STUDY AND ANALYSIS OF REQUIREMENTS
for a
RESEARCH AND TECHNOLOGY CENTER
at
AREA "B"
WRIGHT-PATTERSON AIR FORCE BASE

DEPUTY FOR CIVIL ENGINEERING
AERONAUTICAL SYSTEMS DIVISION

for

AEROSPACE RESEARCH LABORATORIES
AIR FORCE AVIONICS LABORATORY
AIR FORCE FLIGHT DYNAMICS LABORATORY
AIR FORCE AERO PROPULSION LABORATORY
AIR FORCE MATERIALS LABORATORY
SYSTEMS ENGINEERING GROUP
6570th AEROSPACE MEDICAL RESEARCH LABORATORIES
AERONAUTICAL SYSTEMS DIVISION

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A STUDY AND ANALYSIS OF THE POTENTIAL UTILITY OF A CENTRALIZED RESEARCH AND TECHNOLOGY (R&T) CENTER AND ITS COMPONENT ELEMENTS AT WRIGHT-PATTERSON AFB, OH. THE R&T CENTER WOULD CONSIST OF: THE CENTRAL TECHNICAL REFERENCE FACILITIES - THE MAIN AREA "B" TECHNICAL LIBRARY AND THE WPAFB DEFENSE DOCUMENTATION CENTER; THE CENTRAL TECHNICAL CONFERENCE FACILITIES - A 1200 SEAT AUDITORIUM AND FOUR SMALLER CONFERENCE ROOMS; AND THE CENTRAL COMPUTER FACILITIES - A GENERAL PURPOSE DIGITAL, ANALOG, AND HYBRID COMPUTER COMPLEX.

A COMPREHENSIVE ANALYSIS IS PRESENTED OF THE JUSTIFIABLE REQUIREMENTS FOR SUCH A FACILITY. A STRAIGHTFORWARD FACILITY CONCEPT, OPERATIONAL PLAN, AND JUSTIFICATION RESPONSIVE TO THE REQUIREMENTS ARE DEVELOPED AND DESCRIBED.

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RESEARCH AND TECHNOLOGY CENTER

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June 1965

Deputy for Civil Engineering
Aeronautical Systems Division

for

Aerospace Research Laboratories
Air Force Avionics Laboratory
Air Force Flight Dynamics Laboratory
Air Force Aero Propulsion Laboratory
Air Force Materials Laboratory
Systems Engineering Group
6570th Aerospace Medical Research Laboratories
Aeronautical Systems Division

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SECTION I

INTRODUCTION

1.1 GENERAL

Presented in the pages that follow are the results of an analysis of the potential utility of a centralized Research and Technology Center within Area "B" of Wright-Patterson Air Force Base.

The R&T Center is considered to consist of: the central technical reference facilities - the main Area "B" technical library and the WPAFB Defense Documentation Center; the central technical conference facilities - a 1200 seat auditorium and four smaller conference rooms; and the central computer facilities - a general purpose digital, analog, and hybrid computer complex. The computer complex is available for direct access from user laboratories through remote data links. Finally the R&T Center contains certain other service facilities, including a cafeteria used on a day-to-day basis by government employees in the area, and during technical conferences by the conference attendees. A telephone and message center, branch bank, branch post office, and similar facilities are included to minimize the need for off-base travel through the work day.

A comprehensive analysis is presented of the justifiable requirements for such a facility. A straightforward facility concept and operational plan which is responsive to the requirements is then developed and described. Lastly, the justification for the facility is developed, based on the requirements and on the concept described in this report. A subsequent report will include the programming criteria and estimated cost factors for a program designed to bring the R&T Center into being.

1.2 SUMMARY OF REPORT

Section II which follows presents the justifiable requirements upon which the need for a R&T Center must be based. These requirements were obtained as a result of detailed interviews with personnel of the user groups of the proposed center, augmented by an analysis of the projected missions and programs of Area "B" Air Force elements. The expressed requirements were interpreted in terms of the projected future demands expected to be placed on these Air Force elements by evolving technology and the changing problems of national defense.

The three principal technical activities of the R&T Center function in the same general organizational way to serve and coordinate the multiplicity of activities in Area "B". In each case - the library, the conferencing center, and the computing center - the R&T facility serves as the central and largest element of a network of similar facilities located in the user offices and laboratories. The diversity and size of the many activities in Area "B" require that such a network of coordinated facilities exist. Thus, for example, the Flight Dynamics Laboratory requires its specialized library of texts on aircraft control systems design and requires that library close at hand for frequent consultation. The existence of the Main Technical Library, however, relieves that laboratory from the need for a much larger local library of references which are necessary to its work, but which are used less frequently. In turn, the existence of the Flight Dynamics Library relieves the Main Library from the necessity of developing a special collection of texts in flight control system design. In this case, the sum of the utility of the two libraries is greater than the mere total of the two sets of holdings. Similarly, many of the users will have small conference rooms in their own facilities for daily use. The large conference rooms which will be located in the R&T Center will be used only occasionally by any individual laboratory, but often when the entire population of Area "B" is considered.

The above reasoning applies with special force to the computing facilities. Many users have and will continue to have need for specialized computing facilities, but only when all the individual requirements are grouped together can maximum use be made of a general purpose computer. Thus, this facility properly belongs in the R&T Center. The Central Computational Facility is accessible directly from the user groups through remote data links. Multiple-user access to the central computer is planned. These remote links also make it possible to transfer workloads, between the various computers in Area "B" when such action is appropriate. The remote links proposed for the R&T Center are relatively narrow-band telephone line systems, as are used in such multiple-user systems as Project MAC at M.I.T., and the NASA-supported network of the Systems Development Corporation.

The R&T Center as presently envisioned, will not have wide-band microwave links between remotely located computers, as might be used in the experimental computer-communication network required in complex war-gaming operations, but the facility is planned to have the growth capability to be able to incorporate such a feature with no additional major construction costs. The telephone line remote links which will be incorporated in the facility from its inception, will not only be used for computer access but also for automatic access of library data. These data will include the standard card

catalog of the main library and the abstracts prepared in the STINFO Program. It is expected that, in the course of time, the Defense Documentation Center catalogue information will also be available for automatic access.

Finally, the conferencing facility in the R&T Center is envisioned as the primary conferencing facility for Area "B", although special purpose conference facilities will continue to exist in the various user facilities. The overall concept for the R&T Center is developed in detail in Section III.

The R&T Center can be justified on the basis of savings that would accrue from essential elimination of continuing outlays that are now necessary for purposes which the Center would serve. In part, also, it can be justified by savings that would be realized from the enhancement in base efficiency which would be imparted by the Center. These lines of reasoning are all entirely valid. In the final analysis, however, the strongest justification for the creation of the R&T Center rests upon the unique nature of the Area "B" technological complex and the impact of this complex upon national defense.

The Area "B" technological complex of 4400 scientists and engineers represents the U.S. Government's principal concentration of technical skills in the aircraft, and to some extent, in the aerospace field. The spending of ten percent of the entire national defense budget is committed and monitored through the organizations in Area "B". Generally, Area "B" is the focal point of a collaborative effort between the Air Force and the large airframe, electronics, and materials industries. As the focal point, the Area "B" activities provide the communication and coordination function necessary to tie the diverse activities in these industries into one integrated program. By preliminary in-house exploration and by the placement of pilot contracts, Area "B" activities frequently provide guidance and leadership to this vast effort.

In-house exploratory work in the electronics area ten years ago, coupled with carefully considered R&D contracting, led to the present microelectronics industry. More recently the Area "B" in-house work in composite structure boron materials for aircraft is expected to have a pronounced effect on the design and construction of future aircraft. Because of the coordination and leadership role of the Area "B" activities and the necessity for these activities to function together in a close inter-dependent relationship, the funds expended on the R&T Center can be expected to have a large and very direct impact on the quality of future defense procurement. Probably no other single item in the defense budget of comparable magnitude of cost could have a comparable impact. The detailed justification is presented in Section IV.

SECTION II

SUMMARY OF JUSTIFIABLE REQUIREMENTS

2.1 THE REQUIREMENTS IN BRIEF

The requirements for the Research and Technology Center and its component elements were established through the analysis, interpretation, and consolidation of the requirements of the individual users. The individual requirements were originally derived from information obtained through a series of interviews and completed data forms. The results were modified in the light of trends in technology and expected future requirements in aerospace technology. As an example, the Avionics Laboratory now has a dynamic analyzer complex which is presently 90% completed and through the use of which it is possible to operate electronic equipment under actual flight pressure, temperature, shock, and vibration conditions. It is evident that, due to the critical role of reconnaissance in limited warefare, this facility will be expanded and will receive ever increasing use. Under these conditions its associated analog control equipment will have to be supplemented with analog-hybrid and full digital facilities. In this case, it was safe to project that the Avionics Laboratory requirements for the capabilities of a large computing center would gradually and steadily increase. Such projections when made were later checked with the users concerned.

The expected users of the R&T Center are shown in Figure 2-1 on a master plan layout of Area "B" as that area is expected to develop in the next decade. Two groups in Area "C", specifically Flight Test Operations (ASD) and the Foreign Technology Division, are also indicated on that master plan as expected users of the center. The illustration brings out graphically the central location of the R&T Center with respect to the users.

Figure 2-2 shows the expected users of the R&T Center in terms of an organizational chart of the Air Force. The illustration brings out the many different organizations involved and emphasizes the function of the R&T Center in helping to effect a close working coordination between these groups.

The user requirements are summarized in Table 2-1. Consider first the requirements on the library. While a few of the RTD Laboratories indicated that they might have no need for a satellite library, such is not the case with all laboratories, and it is expected that the majority of technical users will have small satellite libraries containing, as a minimum, the back issues of professional journals in appropriate fields. It is expected that the majority of these satellite libraries can be kept small and operated under the general supervision of a

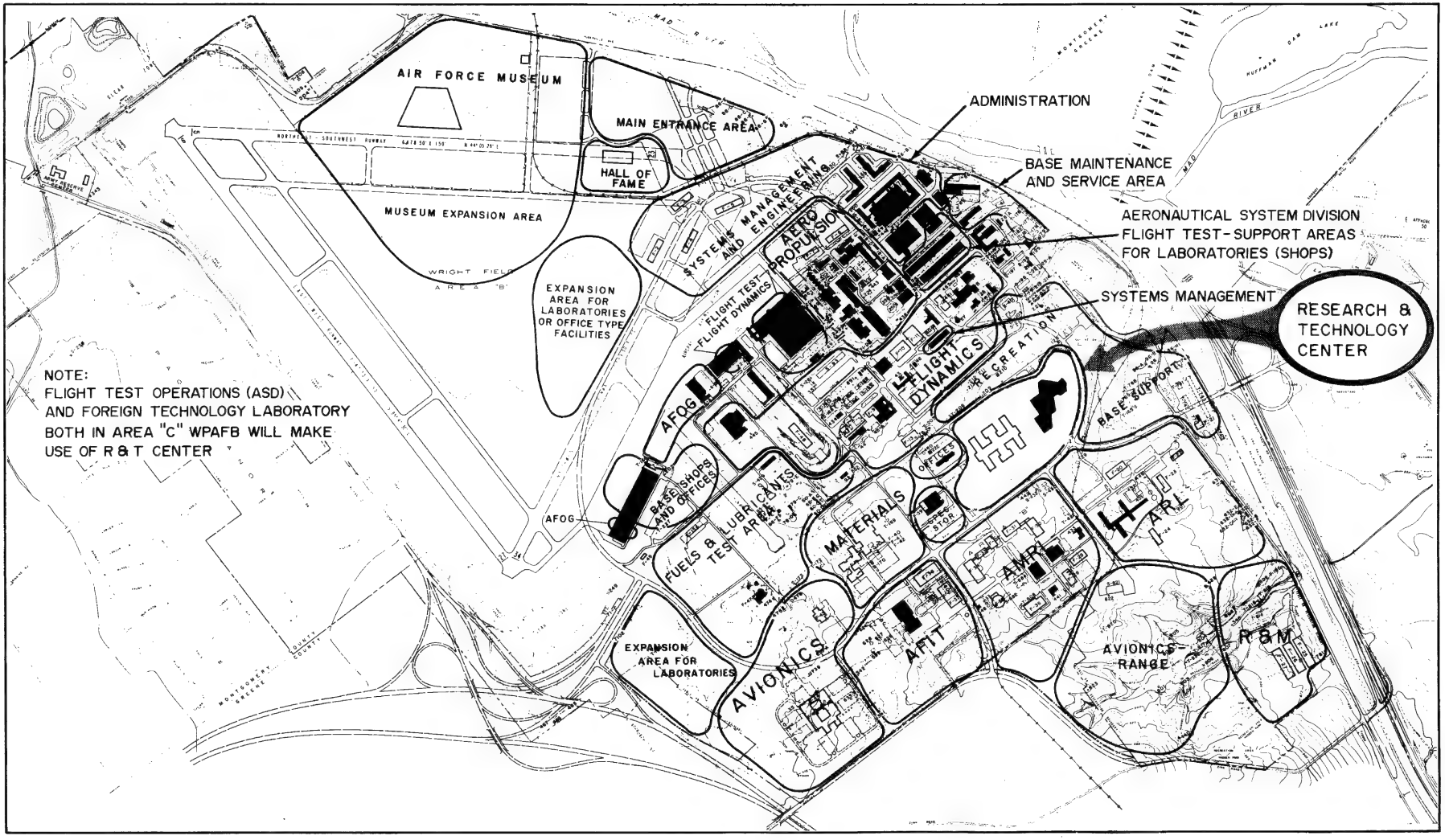

Figure 2-1. Area "B" Master Plan

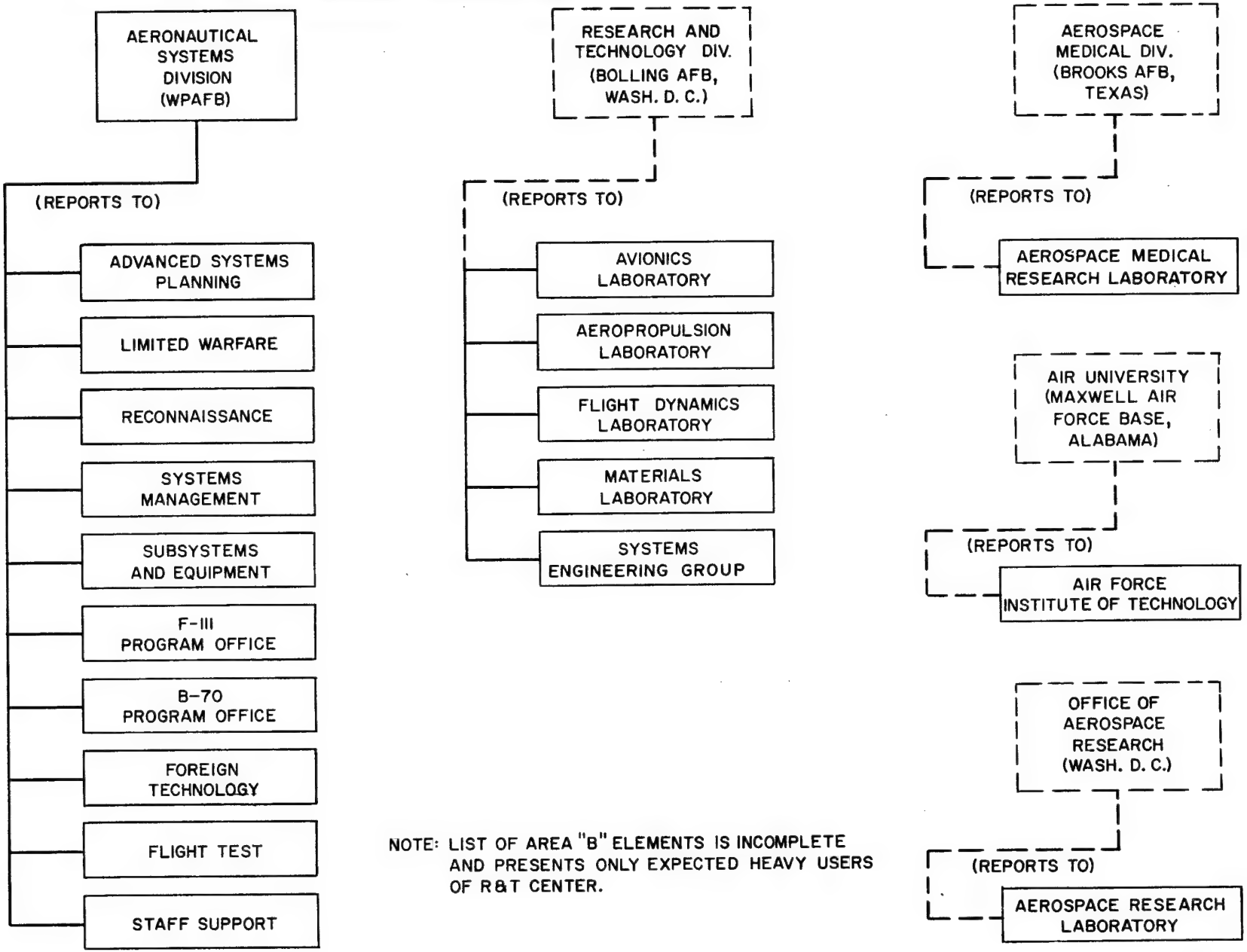

Figure 2-2. Area "B" Users of R&T Facility - with Comments on Computer Requirements

TABLE 2-1

QUALITATIVE USER REQUIREMENTS

Facility	Comment
Technical Reference Facilities:	
Central Technical Library	Required by all user and service groups.
Specialized Individual Libraries	Required by all user and service groups and by ASD.
Defense Documentation Center	Required by all user and service groups and by ASD.
STINFO and Automated Catalog	Required by all user and service groups and by ASD.
Technical Conference Facilities:	
Large Conference Facility (500-2,000)	Required by all RTD laboratories and by ASD, Foreign Technology Division and AFIT.
Smaller Conference Facilities (100-500)	Required by all RTD laboratories and by ASD, Foreign Technology Division and AFIT.
Centralized Computer Facilities:	
Central GP Digital Computer	Required by all RTD laboratories and by ASD, with the exception of Foreign Technology Division.
Centralized Analog or Analog/Hybrid Computer	Required by all user and service groups except DDC and library.
Specialized Individual Computer Facilities	Required by a number of user groups.
Data Links to R&T Center:	
Access link to library catalog	Required by all user and service groups.
Access link to STINFO files	Required by all user and service groups.
Access link to GP Digital Computer	Required by all user and service groups.

responsible individual in the laboratory so that a full time librarian will not be required.

Many users have need for a complete catalog of all Area "B" library system holdings available within their own facility. To respond to such a requirement without involving the expensive associated housekeeping and maintenance operation, the central catalog will be completely automated and available for direct access over a teletype link to all user facilities. This same link will be used for computer access and STINFO data. Current DDC policy is to have automated information searches carried out at the Washington office; those are requested directly from Washington by the user. In the future, such requests may funnel through the R&T Center, so that the user can get all data he needs from a single point. Special provisions for security information will be incorporated in the system as required.

All major users require a large conferencing facility in the 500-2,000 range of capacity. This need is brought about by the inadequacy of the present facilities within Area "B". The Base Theater, Bldg. 680, which has already been formally declared surplus, and which is pictured in Figure 2-3, is currently used for large conferences. For secure conferences, however, it must be held vacant for several days prior to the conference. The preliminary preparation includes checking the theater for monitoring devices, or bugs, and guarding the building from the time of check to the time of conference. Another measure used to meet the need for the large secure conference is the erection of temporary wooden structures covered with parachute cloth and located in the center of one of the aircraft hangers. These arrangements are obviously awkward, time-consuming, and expensive and the results are unsatisfactory. All major users, in addition, have requirements of 100-500 person capacity.

In regard to the computer facility, many users expressed some concern, originally, that the existence of a central computing facility would inhibit their ability to develop their own computing capabilities. The concept of a network of computing facilities which permits individual users to retain their own computers but makes much larger total resources available served to overcome this initial reaction.

All users will have a direct data link to the computer facility. The link serves two purposes. It makes it possible for a multiplicity of users to access the central computer. It makes it possible in cases of over-load of the central computing facility to "farm out" some of the work to computers at the various user locations. This latter feature is discussed in some detail below.

The individual computing facilities required at the user locations are itemized in Table 2-2 with the justification

Figure 2-3. Base Theater

TABLE 2-2

IMPACT OF CENTRAL COMPUTING FACILITY ON REPRESENTATIVE USERS

User	Comment
ASD Organizations:	
Flight Test Operations	Flight Test uses a WPAFB-developed Data Format Converter System which converts flight test data from tape to an IBM-compatible format so that it may be processed at the Central Facility. Flight Test needs are expected to expand.
Comptroller	Comptroller presently uses a large IBM card and disc file system to keep cost control records. Limited programming capability is represented and complex optimization exercises require a link to the Central Facility.
RTD Organizations:	
Systems Engineering Group	This group operates the IBM 7094 II/7044 and REAC/EAI Analog Computer facilities which will become the core of the Central Computing Facility.
Avionics Laboratory	Avionics is developing a unique Dynamic Analyzer for the environmental, electrical, and optical testing of reconnaissance equipment. As this facility develops it will require increased support from the Central Computing Facility. Cold War developments are placing increasing emphasis on reconnaisance systems.
Flight Dynamics Laboratory	The on-line, real-time control of wind tunnel and static test facilities requires satellite computers at Flight Dynamics Laboratory. Data reduction requires support from the Central Facility.
OTHER Organizations:	
Aerospace Research Laboratories	Uses an IBM 1620 for applied mathematics problems. Requires Central Facility for larger problem.
Aerospace Medical Research Laboratories	Does much simulation of biological and neurological functions on computers like PDP-1. Needs in this area are expected to grow and to require increasing use of Central Facility.
Air Force Institute of Technology	Uses an IBM 1620 for student instruction. Will make some small use of Central Facility in training programs.

for the need. These needs have been taken into account in developing the requirements for the central facility.

In addition to the individual requirements which the R&T Center is required to satisfy there are interface requirements upon which much of the justification for the facility is based. The fact that the library facility is centralized and that the computer, main technical library, DDC, and STINFO are in one location means that all the technical reference resources available to Area "B" are readily available to all users. Through the automated catalog and the remote inquiry links, this requirement is realized.

The existence of the centralized digital facility, the centralized analog/hybrid facility, the remote access links, and the satellite computers in individual laboratories will make it possible to shift computing workloads between different computer facilities as unusual conditions require and so use, if necessary, the entire Area "B" complex of computing capabilities. More likely is the need for a close working relationship between two or more computing facilities in user groups working on a common problem.

Finally, and of vital importance if the R&T Center is to be of maximum effectiveness in increasing overall efficiency in Area "B" are the factors of convenience to the user. The present library, for example, is used much less frequently than it should be because of its location removed from users and because of the awkward parking problem. A similar situation holds for the present computing facility. Table 2-3 summarizes the user requirements and includes these factors of convenience which have been specifically mentioned in emphatic terms by all of the users. In Table 2-4, the qualitative requirements have been converted to quantitative space and capability requirements.

2.2 DETAILS OF REQUIREMENTS FOR TECHNICAL REFERENCE FACILITIES

At the present time WPAFB has a Main Technical Library, branch libraries, and field libraries. There is a requirement, springing from the need for more efficient use of total resources, to consolidate these facilities into a single coordinated system with all the technical reference resources in Area "B" available to all users in Area "B". Table 2-5 lists these activities and identifies their missions. The branch libraries are now serviced from the Main Library and that arrangement will continue. The field libraries are supported and administered by the users involved and, while that arrangement will not be changed, the activities will be more closely coordinated with those of the Central Technical Reference Facility. The coordination will be achieved principally through the automated catalog system.

TABLE 2-3

CONSOLIDATED QUALITATIVE REQUIREMENTS

Required Capabilities of Technical Reference Facility	Required Capabilities of Conference Facility	Required Capabilities of Computer Facility
• Large centralized technical library with capability to support all users. • Collocation of technical library and Defense Documentation Center (DDC) necessary to permit access to technical literature and classified reports at one center. • Security provisions and separate building unit required for DDC. • Catalog should be automated to reduce labor and increase ease of access. Catalog access from user buildings is highly desirable. • Over-all Area "B" capabilities in technical literature must include the holdings in the individual libraries in various laboratories. These holdings are available, as required, to any user in Area "B".	• Large conference facility of formal type (on the stage) to accommodate 500-2000 persons. • Multiple conference facilities to accommodate 100-500 persons. • Conference facilities should be capable of handling secure conferences. • All conferencing facilities must have audio-visual aids, sound systems. • Flexibility is essential since the requirements for conferencing facilities will vary with changes in operating patterns. • Over-all Area "B" conferencing capabilities must include the conference facilities expected to be incorporated in new buildings. These facilities will be available for overflow situations.	• Centralized facility with capabilities for digital, analog, and hybrid computing. • Satellite processor capability to control small on-line real-time experiments. • Remote inquiry and operation capability. Multiple user-access. • Capability of handling a "mix" of problems of various security classifications with due regard to security regulations. • Capability for growth in size and in nature to meet future requirements. • Over-all Area "B" capabilities in the computer area must include the computers in individual laboratories which computers can be made available for overload situations.

GENERAL REQUIREMENTS -

It is essential that all the routine requirements be met which are necessary to make the R&T Center an effective and convenient work area. These include a central location, adequate parking, work area near the computers, reading space in the library, etc.

TABLE 2-4

CONSOLIDATED QUANTITATIVE SPACE AND CAPABILITY REQUIREMENTS

COMPUTER FACILITY

PROJECTED ANALOG/HYBRID USAGE

Year	Number of Problems	Operational Amplifier - Hours
1965	80	1.3×10^6
1970	160	2.0×10^6
1975	320	2.7×10^6

PROJECTED DIGITAL COMPUTER USAGE

Year	Equivalent IBM 7094 Hours
1965	11,000
1970	46,000
1975	60,000

SPACE REQUIREMENTS*

General Admin.	Digital	Analog/Hybrid
1250 Ft^2	24,000 Ft^2	12,000 Ft^2

CONFERENCE FACILITY

PROJECTED REQUIREMENTS FOR USE OF R&T CENTER CONFERENCING FACILITY

Time Period	Attendees 100-500	500-2000
Present (Reference)	47	51
1970 (Projected)	205	65
1975 (Projected)	225	110

SPACE REQUIREMENTS*

	Seats	Space
Auditorium	1200	12,000 Sq.Ft.
Conference Rooms	4 @ 200	8,000 Sq.Ft.

TECHNICAL REFERENCE FACILITY

PROJECTED HOLDINGS OF THE CENTRAL TECHNICAL REFERENCE FACILITY

		1970	1975
Main Library WPAFB	Books	98,000	141,000
	Documents	382,000	397,000
	Journals	1,075	1,605
DDC	Documents	600,000	800,000

SPACE REQUIREMENTS*

Main Library WPAFB	29,000 Sq.Ft.
DDC	5,000 Sq.Ft.

*Space allowances for circulation, service areas, etc., are not included in these figures.

TABLE 2-5

PRESENT TECHNICAL REFERENCE FACILITIES AT WPAFB

ACTIVITY	COMMENT
Main WPAFB Technical Library	Provides service to all technical users on the Base by holding books, journals and providing bibliographies and searches.
WPAFB Technical Library Branch Area "A"	Serves Area "A" tenants with holdings primarily in business and management.
WPAFB Technical Library Branch Area "C"-----	Serves Area "C" tenants with holdings primarily in engineering maintenance.
Aerospace Research Laboratory Library	Serves scientists of ARL with holdings primarily in mathematics, physics, and chemistry.
Aeromedical Laboratory Field Library	Serves scientists of AMRL with special holdings in biomedicine, biophysics, bioastronautics and behavioral sciences.
Flight Dynamics Laboratory Field Library	Serves scientists of Flight Dynamics Laboratory with holdings primarily in electronics, electrical engineering and mathematics.
WPAFB Technical Library - Field Staff Judge Advocate	Serves the Staff Judge Advocate with comprehensive legal holdings.
Materials Laboratory Reference File	Serves the specialized needs of Materials Laboratory.
Defense Documentation Center-DFO	Secondary distribution of technical reports of RDT&E sponsored by DOD.
Foreign Technology Division Library	Special intelligence type information held for FTD centers and laboratories to serve intelligence analysts and deputies.
Air Force Institute of Technology	An academic library to serve the students and faculty of AFIT.

Table 2-6 shows the component elements of the Technical Reference Facility of the R&T Center. Note that, for security reasons, the Foreign Technology Division holdings are not to be incorporated into the overall facility. Further, the Air Force Institute of Technology library is held separate to insure that student needs may be met without putting an undue load on the overall facility.

Many users have requested that a complete catalog of all the library holdings in Area "B" be available at their facility. This requirement will be met by automation of the catalog and by making the automated catalog available through the remote computer access link which will have stations at all major user facilities.

The Department of Defense has established a Scientific and Technical Information (STINFO) Program which is supported within the Air Force by procedures outlined in Air Force Regulations AFR 80-28. The program is designed to insure that scientific and technical information generated by RDT&E programs is used to maximum effectiveness. Abstracts prepared under STINFO activities will be referenced through the automated catalog and their availability coordinated through the Central Technical Reference Facility.

The Defense Documentation Center (DDC) will be housed separately from main library, but also in the R&T Center in response to the need to make this center of DOD reports also convenient to the user. This library currently houses 400,000 documents and is expected to expand to 600,000 in 1970 and 800,000 by 1975. DDC holdings are automated in the DDC Center in the Washington, D.C. area. Requests for literature of DDC files are forwarded to Washington from the field office and the practice will be followed within the new facility.

With the foregoing in mind, it can be said that the vast majority of all the reference documents, texts, and journals in the Area "B" complex will be readily available to any user at Area "B" through the facilities of the R&T Center. This arrangement is responsive to the overall requirement that the utility of this large and unique resource be increased.

Consider now the general requirements placed upon the library facility. These are enumerated in Table 2-7. The network of coordinated library facilities and the concept of the R&T building itself as described in Section III are responsive to those requirements.

2.3 REQUIREMENTS FOR CONFERENCE FACILITIES

It has been estimated as a result of interviews of major Area "B" users, and through questionnaire returns, that essentially

TABLE 2-6

COMPONENTS OF CENTRALIZED LIBRARY SYSTEM OF R & T COMPLEX

LIBRARY	HOLDINGS (NO. OF VOLUMES) Present	1970	1975	STATUS UNDER CENTRALIZED SYSTEM
Main WPAFB Technical Library	B 72,000 D 15,000 J 950	92,000 20,000 1,050	135,000 35,000 1,575	Core of library system. Holdings are in automated catalog.
WPAFB Library Branch in Area "A"	B 2,000 D * J 70	6,000 * 90	10,000 * 100	Serviced from Main Library as branch. Holdings not in automated catalog.
WPAFB Library Branch in Area "C"	B 1,300 D * J 67	1,500 * 80	1,700 * 95	Serviced from Main Library as branch. Holdings not in automated catalog.
Aerospace Research Lab Library	B 10,000 D 14,000 J 250	11,000 15,500 275	12,000 18,000 300	Serviced from Main Library as branch. Holdings incorporated into automated catalog.
Aeromedical Lab Field Library	B 10,000 D 14,000 J 500	12,000 16,000 550	14,000 18,000 600	Activity coordinated with that of Main Library. Holdings incorporated into automated catalog.
Flight Dynamics Lab Field Library	B 8,298 D 10,000 J 350	12,000 30,000 375	17,000 50,000 400	Activity coordinated with that of Main Library. Holdings incorporated into automated catalog.
Staff Judge Advocate Field Library	B 11,000 D *	12,000 *	13,500 *	Activity coordinated with that of Main Library. Holdings not in automated catalog.
Systems Engineering File (ASD)	D 200,000	275,000	300,000	Activity coordinated with that of Main Library. Holdings referenced in general terms in automated catalog.
Materials Laboratory Reference File	D 25,000	60,000	100,000	Activity coordinated with that of Main Library. Holdings referenced in general terms in automated catalog.
Defense Documentation Center	D 400,000	600,000	800,000	Automated catalogue of all holdings maintained in Washington, D.C. area. WPAFB DDC will be located in R & T Center and its activities coordinated with those of Main Library.

CODE: B = Books
D = Documents
J = Journals

* = Essentially none

TABLE 2-7

REQUIRED CAPABILITIES OF CENTRAL TECHNICAL REFERENCE FACILITY

Requirements	Justification/Reason
General	
A centralized facility with collocation of the Central Technical Library and the Defense Documentation Center.	The difficulty of literature search and cross-referencing when these two functions are in widely separated areas must be overcome to reduce time lost. Reduce duplication of materials and efforts.
Centrally coordinated cataloging.	This service will provide better coordination of interdisciplinary requirements in the specialized areas of the branch libraries.
Increased responsiveness through automation.	Provides more timely and thorough acquisition and processing of holdings. Improved service with reduced load on the librarian. Improve the completeness and reliability of response to the users.
Building Layout	
Adequate functional facilities.	Necessary normally as a matter of good library services; quiet work space and privacy must be available for base scientist researching classified and/or proprietary items.
a. Shelving areas	Necessary to store books, periodicals, documents for convenient access.
b. Microfilm area	Necessary to store, retrieve, view and print microfilm material.
c. Processing area	Necessary for the processing associated with library and technical reference center operations.
d. Office area	Necessary to house the various organizations associated with the library and central technical reference file.
e. Reading room	Necessary to accommodate the user's need to scan or research library materials.
f. Carrel area	Necessary to enable users to study document holdings.
g. Unclassified storage area	Necessary to house unclassified books, documents, and periodical publications.
h. Secure storage area	Necessary to house classified technical reference material.
Access from User Facilities	
STINFO data link to the central computer and focal points.	Provides the complete span of information retrieval to complement collocation of the technical library and document center.
Holdings at User Facilities	
Specialized individual technical reference facilities.	The continuation of selected specialized facilities, such as the Legal Library of the Judge Advocate's Office and the Medical Library is standard procedure wherever specific groups of professionals have well established operations for specialized holdings.

all of the major users of the Area "B" complex have a requirement for a large auditorium facility (1,200 seat capacity) and for multiple smaller conference rooms in the range of approximately 100-500 seat capacity. Table 2-8 depicts the quantitative conferencing requirements gathered through the interviews and questionnaire, while Table 2-9 gives the qualitative requirements. The conferencing requirements are based upon experience and projected usage and are affected by the following factors:

- At the present time conference budgeting is not a line item and cannot be easily identified so that much interviewing was required to develop the requirements.
- Since large on-base facilities have not been available, past growth of requirements has been constrained sometimes at the price of overall effectiveness.
- Many users expect new requirements to be generated once the facility is available and personnel can make use of such a facility.
- The total conferencing requirement includes both on-base and off-base conferencing requirements -- it is assumed that, with an adequate facility, conferences will be held on-base.

At the present time, conference rooms are available in approximately nineteen different buildings for secure conference sessions within Area "B" of WPAFB and are listed in Table 2-10. By and large, however, these facilities are inadequate to meet major requirements. A description of the approximate number and sizes of available conference rooms, and those required for the proposed R&T Center is provided in Figure 2-4. No permanent secure facilities are available for conferences larger than 545, which is the capacity of Building 680, the old Base theater building. In addition to being obsolete, the capacity of this building is not large enough to meet users' needs.

In summary, the present conference facilities at WPAFB are inadequate and obsolete. Conferences are now being held in makeshift facilities which, in addition to entailing the expense of setting up and dismantling temporary facilities, results in decreased effectiveness of the conferences which are held.

The diagram of Figure 2-5 indicates the extent of utilization of the projected facility. Note that conferences from 100-500 in attendance will utilize the small conference facility

TABLE 2-8

QUANTITATIVE CONFERENCING REQUIREMENTS, PAST, PRESENT, AND FUTURE

Type of Conference	TIME PERIOD											
	1965				1970				1975			
	100 to 500		500 to 2000		100 to 500		500 to 2000		100 to 500		500 to 2000	
	A	D	A	D	A	D	A	D	A	D	A	D
1. ASD-RTD-SEG Technical Symposium	10	50	3	15	14	70	7	35	14	70	16	80
2. AFIT - Commencements, Commander's Call	1	.5	13	6.5	1	.5	13	6.5	1	.5	13	6.5
3. AMRL - Technical Symposiums	1	5	None	None	3	15	1	5	5	25	1	5
4. DDC - Orientation Conferences	2	1	None	None	4	2	None	None	4	2	None	None
5. ARL - Technical Symposiums	None	None	None	None	1	5	None	None	2	10	None	None
6. FTD - Special Intelligence Meetings	5	7.5	6	3	7	10.5	6	3	10	15	6	3
7. ASD - Large System Source Selection and Ad Hoc Meetings	4	90	3	1.5	4	90	6	3	4	90	6	3
8. ASD - Commander's Call	24	12	12	6	24	12	12	6	24	12	12	6
9. SEG - Commander's Call	None	None	6	3	None	None	6	3	None	None	6	3
10. RTD - Commander's Call	None	None	6	3	None	None	6	3	None	None	6	3
11. Air Force Cadet Meetings	None	None	2	1	None	None	2	1	None	None	2	1
TOTAL	47	166	51	39	58	205	59	65.5	64	224.5	68	110.5

A - Annual Number of Conferences Held
D - Utilization of Conference Facility in Days

TABLE 2-9

QUALITATIVE CONFERENCING REQUIREMENTS

REQUIREMENT COMMENT	USERS										
	Avg	APL	FDL	ML	SEG	AMRL	ASD	AFIT	ARL	DDC	FTD
Require R&T Center Conference facility of 500-2000 capacity	x	x	x	x	x	x	x	x			x
Require R&T Center Conference facility of 100-500 capacity	x	x	x	x	x	x	x	x	x	x	x
Require secure conference facilities	x	x	x	x	x	x	x		x	x	x
Incorporate CCTV to Laboratories			x								
After facility is available new requirements will rapidly develop				x	x		x				
Use facility for technical symposia	x	x	x	x	x	x	x		x		x
Use facility for general symposia and administrative uses	x	x	x	x	x	x	x	x	x	x	x
Require smaller or panel committee rooms	x	x	x	x	x	x	x	x		x	x
Require large auditorium for films	x	x	x	x	x	x	x	x	x	x	x
Include Reproduction Facilities		x									
Plan to accommodate general conferencing of 100 or less within individual labs	x			x		x		x	x		NA

TABLE 2-10

PRESENT CONFERENCING FACILITIES AVAILABLE

FOR CLASSIFIED MEETINGS

Conference Room Capacity	Building Number	Security Classification
30	7	Secret
30	11A	Confidential
25	12	Secret
25	14	Secret
30	14	Secret
50	14	Secret
50	15	Secret
25	18A	Secret
30	20	Secret
70	20	Secret
30	22	Secret
50	22	Secret
60	28	Secret
35	28	Confidential
100-125	45	Secret
50	50	Secret
25	52	Confidential
75	125	Secret
50	126	Secret
50	196	Secret
15	441	Secret
150	450	Secret
545	680	Secret
25	206	Secret

NOTE: See text for comment on limitations of conferencing capability in Building 680 (Base Theatre). Note size limitations on all other conferencing facilities.

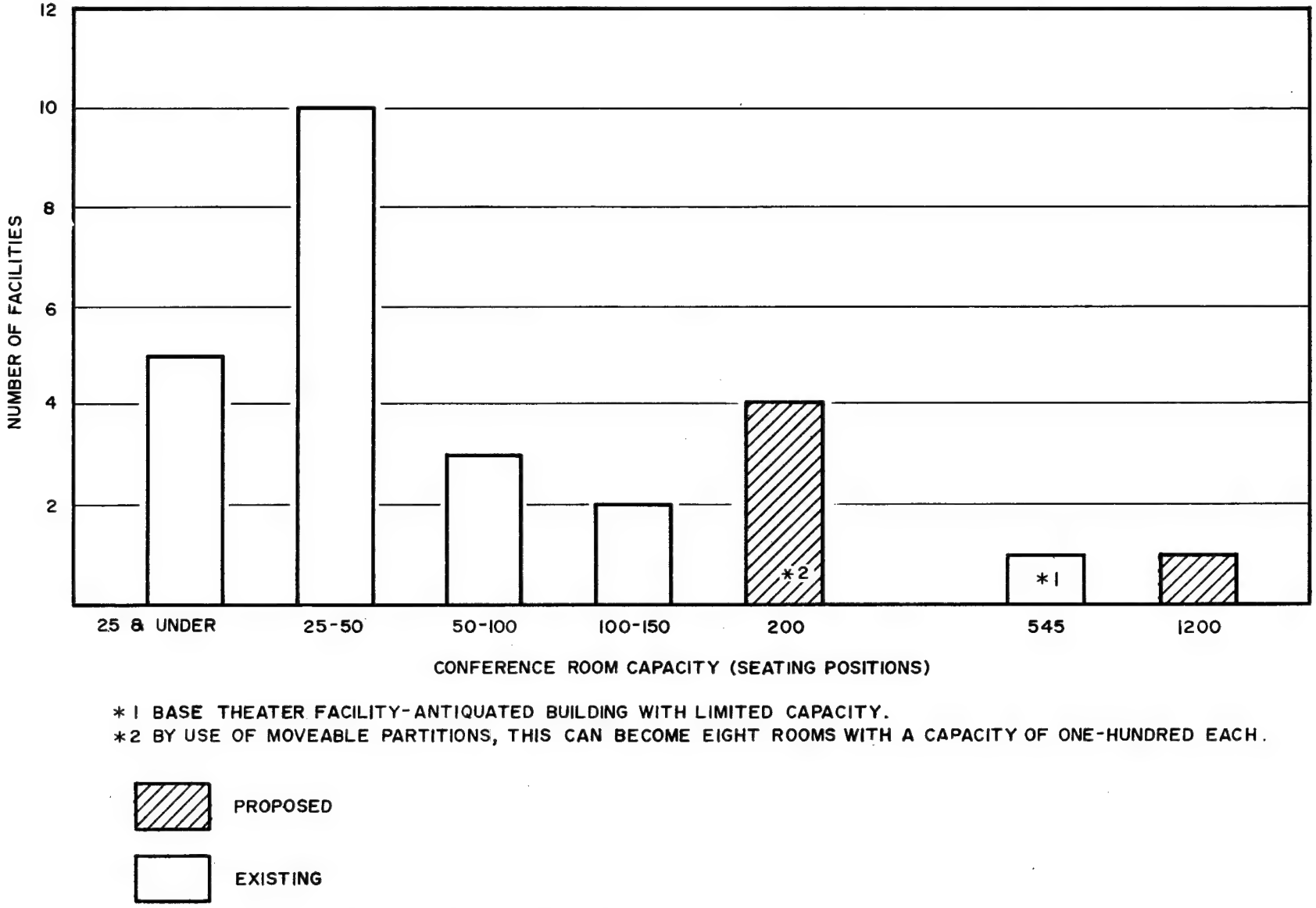

Figure 2-4. Secure Conference Facility Requirements

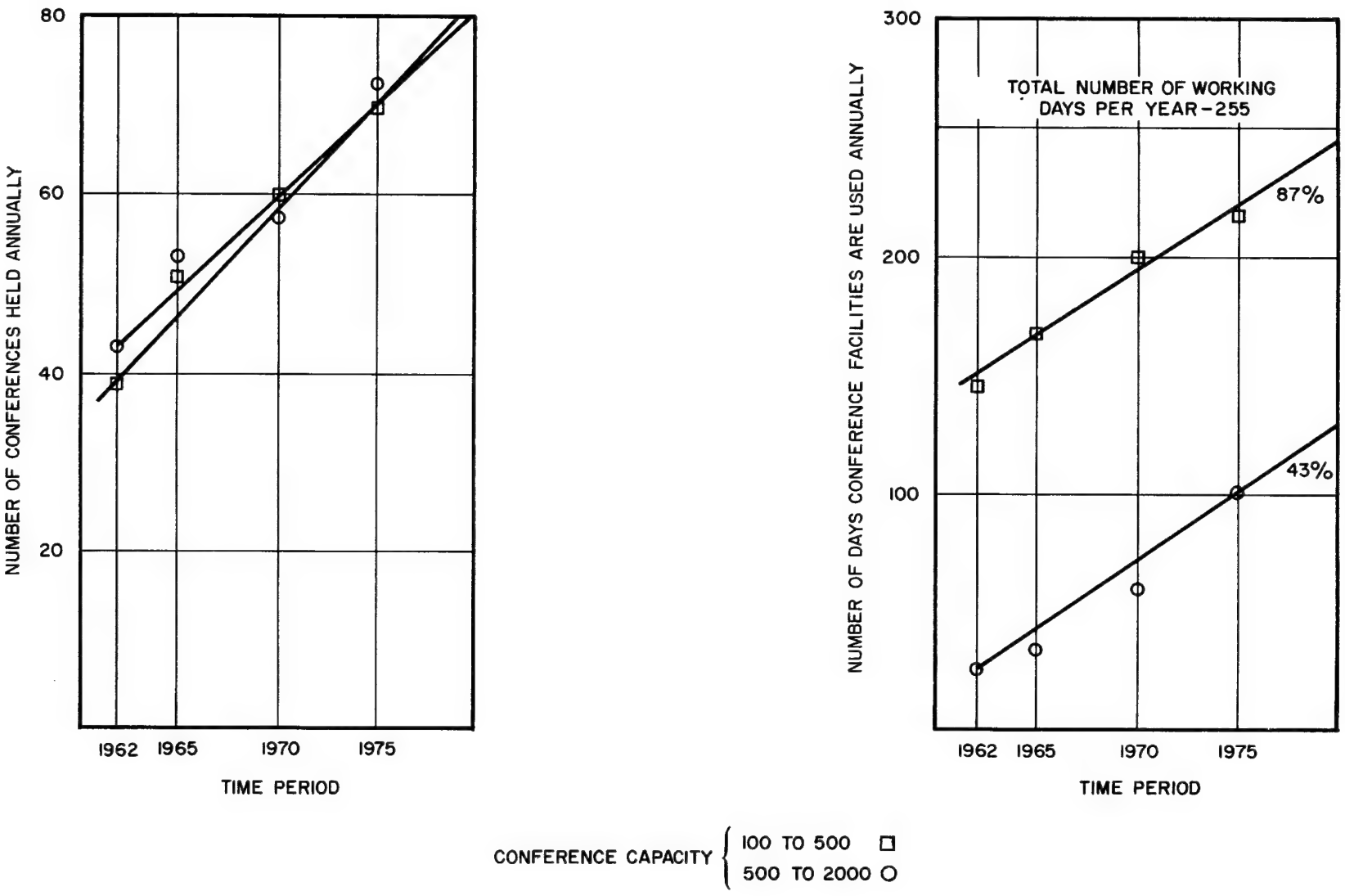

Figure 2-5. Utilization of Conference Facilities

approximately 87% of the available time. The large conference facility (500-2,000)* will be utilized approximately 43% of the available time. It is expected that the very high utilization of the smaller facility will be reduced as the individual laboratories obtain facilities, located within their own complex, and capable of accommodating internal meetings of up to 150 seats in capacity. The 87% rate would actually indicate severe scheduling problems. The 43% utilization for the large 1,200-seat capacity auditorium projected for 1975 is quite high as compared to utilization rates of auditoriums associated with schools or business activities.

Table 2-11 summarizes the type and number of attendees for conferences held in the past. Note that information films such as the recent "Air Force Reports to Congress" are shown to all personnel in Area "B" and, at present, can only be handled through an extended period of multiple showings. While there is no justification for an auditorium capable of simultaneously seating all personnel in Area "B", a single large facility required for other purposes as well would serve to reduce the number of such multiple showings in order to reach all personnel.

2.4 DETAILS OF REQUIREMENTS FOR CENTRAL COMPUTING FACILITY

2.4.1 General

The requirements for the computing facility are necessarily the most technically complex in addition to being probably the most significant of the three basic sets or requirements developed here. Technical and management activities are increasingly built around computer analyses. The requirements for computers and computing capabilities at Area "B" are presented here in four subsections. The first two sections (2.4.2 and 2.4.3) deal with the individual requirements and the required performance capabilities of the digital computing facility. The third subsection, Section 2.4.4, deals with the needs for analog and hybrid computers. Finally, the last section presents the space requirements for the total central computing facility.

2.4.2 Digital Computing Facility - Individual Requirements.

Table 2-12 shows the present status of digital computer usage at Area "B", based on information made available during the investigative phases of the study. Table 2-13 summarizes the projected individual qualitative facility requirement anticipated in the year 1975. All of the organizational elements listed in Table 2-13 will continue to need the support provided by the Central Computing Facility.

Through the use of remote access stations and multiple-user capability in the central computer, the central computer capabilties can be made readily available at remote locations. Remote

*This consists of 1200-seat auditorium plus four 200-seat conference rooms.

TABLE 2-11

TYPES OF CONFERENCING HELD IN AREA "B"

Conference	Approximate No. of Attendees
Management, Administrative, and Orientation	
Research Progress at Wright-Patterson	500-1000
Commanders' Call	1200
Special Intelligence Meetings	700
Orientation Conferences	400
DOD Briefings	800
Contractor Related Activities	
Classified Briefings	500
Bidder Briefings and Source Selection Board Meetings	200-400
Source Selection Team Conferences	200-300
Air Force/Industry Planning Seminar	500
STINFO Conference	300-500
Technical Conferences	
Bionics Conference	500-2000
National Aeronautical Electronics Conference	300-1000
Air Force Academy Cadets Briefing	1200
Materials Applications Symposiums	1500-2000
Advanced Materials Symposium	500-600
Non-Destructive Testing Symposium	300
Aerodynamics Deceleration Symposium	250
Environmental Control/Thermal Symposium	300
Bearings Conference (Materials Lab.)	250
Aerospace Expandable Structures Conference	300
Aerothermodynamic/Elastic-Structural System Environmental Tests (ASSET)	300-350
Adaptive Control Conference	300-500
Aerospace Thermoelastic Conference	200-300
Inertial Coupling Conference (Flight Dynamics Laboratory)	200-250
Classified Advanced Testing Methods Conference	300-600
American Society of Photogrammetry Conference	900-1000
Laboratories Open House	100-500
Information Films (See text)	8000
Air Force Institute of Technology Activities	
School of Logistics Commencement	200-300
School of Engineering Commencement	1000

TABLE 2-12

PRESENT DIGITAL COMPUTER USE

Organizational Element	% Use of Central Facility	Existing Individual Computer Facility	Planned Ind. Computer Fac.	Primary Function of Individual Computer
Flight Dynamics Laboratory	24	CDC 160A	-	On-line control/data reduction for wind tunnels
		CDC 1604	-	On-line real time control/data reduction for static test facilities
Aero Propulsion Laboratory	8	None	None	
Materials Laboratory	3	None	None	
Avionics Laboratory	10	None	Elint Systems Simulator Computer	On-line, real time control/data reduction
Systems Engineering Group (Includes SESC Use)	28	IBM 7094 II/7044 Direct Coupled System	-	Currently used as Centralized Facility
Aeronautical Systems Div.	6	IBM 1410 (Comptroller)		Administrative
		DDP-24 (Flight Test)	Data Format Converter	Converts test data from tape to IBM compatible format
Aerospace Research Laboratories	10	IBM 1620	Improved Facilities	Research in Applied Mathematics and Programming
Aerospace Medical Research Laboratory	4	PDP-1 PB-440	Medium Size Computer	On-line, real time control/data reduction
Air Force Inst. of Technology	-	IBM 1620	-	Training tool for student use.
Others (Include AFIT Use)	7	None	None	

- No data available

TABLE 2-13

PROJECTED INDIVIDUAL FACILITY DIGITAL COMPUTATION REQUIREMENT
(1975)

ORGANIZATIONAL ELEMENT	STINFO DATA LINK TO CENTRAL FACILITY	SMALL, GENERAL PURPOSE INDIVIDUAL COMPUTER FACILITIES	SPECIALIZED INDIVIDUAL COMPUTER FAC.	ON-LINE, REAL TIME REMOTE ACCESS	REMOTE ACCESS STATION(s)	NEED FOR CENTRALIZED COMPUTER FACILITY	
Flight Dynamics Laboratory	YES	NO	YES	YES	YES	YES	
Aero Propulsion Laboratory	YES	NO	NO	NO	YES	YES	
Materials Laboratory	YES	NO	NO	NO	YES	YES	
Avionics Laboratory	YES	NO	YES	YES	YES	YES	
Systems Engineering Group	YES	NO	NO	NO	YES	YES	
Aeronautical Systems Division	YES	*YES	YES	NO	YES	YES	
Aerospace Research Laboratory	YES	YES	NO	YES	YES	YES	
Aerospace Medical Research Laboratory	YES	NO	YES	YES	YES	YES	
Air Force Inst. of Technology	YES	YES	NO	YES	YES	YES	
Technical Library	YES	NO	NO	NO	NO	YES	
Others	YES	NO	NO	NO	NO	YES	

*Comptroller

access stations with a variety of operating speeds and features can be obtained as "off-the-shelf" items today, and it is expected that extensive improvements will be made in them over the next decade. The range of operating speeds available is from 10 characters per second through 300-400 cards a minute input devices, or 300-400 lines per minute output printers. These stations range in capability from simple input/output devices through remote access stations that are essentially special purpose computers for formatting and editing the input/output information and carrying out a limited amount of computation.

The currently available remote access stations operate over toll quality telephone lines. With the short distances involved for remote access in Area "B", the current state-of-the-art allows transmission of 2,300 to 3,000 bits per second over a single telephone line - sufficient capability to provide, for example, an individual user with about one-third of the input and output capabilities currently available to the users when he takes his problem to Building 57 for running on the Central Facility. Should the future requirements for the transfer of data exceed this rate, two, three or any number of telephone lines can be used in parallel to provide the required information carrying capacity. Because of the heavy loading projected by some users - notably Flight Dynamics Laboratory, it is possible that they may require several remote access stations, dispersed throughout the facility.

In addition to remote access stations, which will access the computers via a queuing memory on a priority basis, a computer-to-computer link providing on-line real-time access will be required. These links can be over good quality telephone lines. The individual facilities can be sized to handle the majority of the specialized problems, and make use of the real-time link to augment the capability for those cases that would exceed the capacity of individual facilities. At the same time, the electrical linking of all computers with the Area "B" complex would be required in order to provide a backup capability for the Centralized Facilities.

Based on the information obtained, only four organizational elements - Flight Test, Flight Dynamics Laboratory, Avionics Laboratory, and the Aerospace Medical Research Laboratory - have a requirement for specialized individual facilities. This requirement arises from the need for real-time, on-line data reduction and control of simulators and test facilities. It is recognized that other elements may also develop such needs in the future, but there are no indications of this at the present time.

Three elements of Area "B" - Aerospace Research Laboratory and Air Force Institute of Technology, and the ASD Comptroller - presently have and will continue to have a requirement for a

small general purpose computer facility. At Aerospace Research Laboratories the general purpose computer is used as a research tool in the applied mathematics laboratory for developments in both mathematics and programming. At Air Force Institute of Technology the computer is used as a training tool, to allow students to become familiar with the operations and capabilities of computers. The comptroller's computer is essentially a large, slow memory with small processor and is used for accounting purposes.

The users mentioned above as well as other elements which currently have their own general purpose installations, may prefer to give up or reduce the scope of work in their individual facilities and make greater use of the centralized facility if a multiprocessor with adequate capacity is available within the centralized computer facility, and if a properly sized remote access station is available to them. In any event, it is anticipated that no user who can presently justify an individual facility will give up this facility until it is demonstrated to him that the centralized facility can provide him better service at lower cost.

Table 2-14 summarizes the quantitative requirements of the individual organizational elements within Area "B" for use of the centralized computer facility. These data form the basis for the consolidated quantitative requirements given in previous sections, and have been extracted from the individual responses to questionnaires and interviews. Explanatory notes for the table are as follows:

- Two of the organizational elements interviewed - Foreign Technology Division and Defense Documentation Center - do not appear on the table because they will place no demands on the centralized facility. The Foreign Technology Division processes highly sensitive information and thus maintains its own computer facilities. Current policy on Defense Documentation Center is for all computer processing to be centralized at the main office in Washington, with the Dayton Field Office being primarily a depository for microfilm copies of the documents.

- The "others" category under Organizational Element reflects usage by elements of both Wright Field and the Air Force in general, for example, the Ballistic Systems Division, and Electronic Systems Division. The individual usage by these elements is relatively small, therefore, is not specifically identified. Computer use and other characteristics were estimated from historical data. While not a separate organizational element, the STINFO program has been broken out

TABLE 2-14

PROJECTED INDIVIDUAL REQUIREMENTS FOR CENTRALIZED COMPUTER FACILITIES

Operational Element	Equivalent Hours, IBM 7094			Turnaround (%)			Programming (%)			Approx. Dist. by % of Type of Work	
	1965	1970	1975	Immediate	Same Day	More Than One Day	Open Shop	Closed Shop	Off-Base	Recurring or Production	Unscheduled (Short Notice Tasks)
Flight Dynamics Laboratory	2500	5800	8300	5*	35*	60*	40*	40*	20*	20%	80%
Aero Propulsion Laboratory	794	981	1003	6	54	40	68	13	19	40%	60%
Materials Lab.	440	550	620	0	10	90	10	80	10	0%	100%
Avionics Lab.	1900	3600	4750*	10*	50*	40*	60*	20*	20*	50%	50%
Sys. Engr. Gp.	1700*	2820*	3400*	10*	60*	30*	50*	40*	10*	70%	30%
Aeronautical Systems Div.	725*	1410*	1800*	25*	50*	25*	20*	20*	60*	50%	50%
Aerospace Res. Laboratories	1371	2910	5070	10	77	13	87	10	3	10%	90%
Aerospace Med. Res. Lab.	502	630	713	10	50	40	68	12	20	100%	0%
Air Force Inst. of Technology	470	860	1500	10	30	60	100	0	0	10%	90%
Others	600*	1160*	1500*	10*	50*	40*	10*	90*	0*	0%	100%
STINFO Program	100*	300*	900*	10*	20*	70*	0*	15*	85*	20%	80%
Technical Lib.	0*	112*	618*	10*	20*	70*	0*	10*	90*	20%	80%
Total/Weighted Average	11,102	21,113	30,174	9	49	42	52	30	18	33	67

*No direct user requirements available - Figures are based on contractor's analysis extrapolation.

separately, because, under current DOD policy, it will be applied to all organizational elements; the computer requirements of this program are unique enough to warrant special treatment. While STINFO operations are being undertaken by a number of laboratories, only one - Materials Laboratory - actually has implemented a computerized information storage and retrieval system of the type contemplated by the STINFO Program. The projections for computer usage and other parameters were estimated on a conservative basis from the experience of the Materials Laboratory and the projected requests for bibliography and literature searches that were gathered as a part of the investigative phase of this study. It was estimated that a large, modern, general purpose digital computer could carry out on the order of 70 complete bibliographies per hour. Note particularly that it has been assumed that 85% of the programming activity will be accomplished off-base; it has been further assumed that a uniform method of programming will be arrived at, perhaps at DOD level, for application to this program.

- The bottom line in the Table gives totals for computer usage in equivalent hours of IBM 7094 for the calendar years 1965, 1970 and 1975, and the weighted average of the other three parameters. Projected computer usage in 1975 has been used as a weighting factor for these three auxiliary parameters.

  (1) Turnaround requirements are also given in terms of the percentage of machine time in three catagories: where the results are needed immediately - this includes the real-time, on-line requirements; where they are needed the same day; and where the results are needed as soon as practical, but the user can wait at least one day for them.

  (2) The column headed Programming indicates the percentage of the overall programming activity that is carried out on an open-shop basis, where the user does his own programming, or in a closed-shop where personnel of the centralized facility do the programming. Off-base programming refers primarily to contractor-generated programs or standard programs developed by central agencies.

  (3) The column headed Distribution gives the percentage of computer usage where the occurrence of a requirement is predictable or recurring, and those requirements that are generated essentially at random.

- The data with asterisks in Table 2-14 indicate that no direct estimates were available from the user, either in response to questionnaires or as a result of interviews. In the case of the Systems Engineering Group and the Aeronautical Systems Division, historical records of past usage were obtained and used as a basis for future projection. Percentage increases for these organizations were estimated from the average increase projected by similar users in Area "B". Usage for the Systems Engineering Group included the computer time used by the computer group itself - this consists primarily of the time necessary to improve and maintain the software systems of the centralized facility.

Turnaround, programming and distribution for those elements which did not report directly were estimated from an analysis of the mission/function of the organization, coupled with an interpretation of statements by the principal users within the organizations.

Estimates of the computer usage by the technical library were based on two assumptions. First, it was assumed that at some time in the future the ordering of literature, updating of catalogs, and card files, and preparation of indexes would be carried out to some degree on the computer. In addition, it was assumed that industry will develop programs similar to the STINFO program and apply them to non-Government reports in the same manner in which the Defense Documentation Center is covering the Government reports.

2.4.3 Digital Computer Facility - Required Performance Capabilities

During the investigative phase of this study, a number of general comments were made by the users that could have been interpreted as requirements for the use of digital computers in Area "B". It was necessary to establish which of these requirements were, in fact, justifiable. The requirements and their justification/reason are collected in Table 2-15, which also indicates how many of the users mentioned the requirement. In preparing the table, there were several requirements that were felt to be justified, but had not been specifically mentioned by the users; these have also been included and are indicated by the fact that a zero is recorded under the column of number of mentions. Note that several requirements have been included for which no justification was either given or apparent, based on the data obtained. These are listed at the very end of the table and are identified as such.

The functional parameter selected to be used to obtain quantitative requirements in the 1970-1975 time period was the

TABLE 2-15

CONSOLIDATED QUALITATIVE DIGITAL COMPUTATION REQUIREMENTS

Item Number	Number of Mentions	Requirements	Justification/Reason
1	17	Continued need for a centralized computer facility shared among the elements in Area "B"	Individual users do not have a sufficient workload to justify having their own large computer, but a large share of the computational requirements must be met by such a large system. Programming assistance can be made available by highly trained programmers. Scientific, technical and management personnel prefer to concentrate on their own special field, and leave the operation of a computer facility to the specialists in this field. Centralized operation provides maximum efficiency in the utilization of both personnel and equipment because the requirements of the individual users fluctuate greatly and consolidation results in a tendency to even these fluctuations out. Centralization of the computer facility allows for application of uniform standards of quality, resulting in a better grade of service to all users.
2	5	Specialized Individual Computer Facility located at the user's laboratory.	Where a continuing requirement exists for a large number of highly specialized computations, it is generally more economical to have these done by computers or equipment designed specifically for this purpose, rather than have them done by general purpose centralized computer.
3	7	Remote Access Stations, located within the individual laboratory facility, and capable of direct connection to the centralized computer.	Efficient utilization of scientific, technical, and management personnel. Historically, the average computer run per access is less than 5 minutes; however, a half day may be required to go to and from the centralized facility, and to wait in line to get on the computer. More rapid turnaround. Data are developed at the individual laboratories, but results of computations on this data cannot be obtained immediately unless remote access is available. More efficient open shop programming and program de-bugging. Without remote access capability, open shop programming and program debugging must eventually be carried out with the programmer at the centralized facility where he cannot refer to his information base or consult with his colleagues.

TABLE 2-15

CONSOLIDATED QUALITATIVE DIGITAL COMPUTATION REQUIREMENTS (CONT'D)

Item Number	Number of Mentions	Requirements	Justification/Reason
4	4	On-line and/or real-time remote access to centralized computer. This differs from the requirement #3 in that no queuing memory is inserted between the remote user and the central processor.	Trend toward more sophisticated model test facilities and simulators will require that data be fed to the computer on-line, and the results will be required in time to significantly affect the operation of the test facility or simulator Open shop programmers can utilize on-line program de-bugging, and shorten the length of time necessary to prepare a program.
5	4	Small, general purpose digital computer facilities that are located at the individual laboratory.	With the existence of a centralized facility with adequate capacity to meet the needs of the user community, coupled with the existence of remote access stations that in effect put the computer in the user's laboratory, the need for such a small facility does not appear justifiable except in special cases. These special cases are discussed in more detail under the following section on individual requirements.
6	2	Electrically integrating via a good quality telephone line, the specialized individual facilities dispersed throughout Area "B".	Specialized individual computer facilities generally are smaller and have distinct limitations in terms of computational, memory and input-output capacities. Electrically tying these equipments to the large scale, high-speed central facility would provide them with a significant backup capability for those applications where their limitations become serious. Additionally, at least some of the specialized facilities could be utilized as reserve capability by the centralized facility, if they are not being loaded 100% of the time.
7	No mention by users but requirement is considered to exist.	A centralized facility with adequate computational capacity to meet the critical needs of Area "B", with a built-in growth capability so that the capacity can be increased as the demand for it increases.	A major potential pitfall of the centralized operation is that it is not large enough to satisfy the needs of the users. For example, such administrative functions as preparing paychecks or PERT readouts must be carried out with inflexible time limits and cannot be delayed. With the advent of multiprocessors and multiprogramming, and with the large usage projected for Area "B", it is reasonable to assume that such needs can be met unfailingly as long as the overall capability of the computer is large enough, and scheduling of its usage is carried out efficiently.
8	7	Adequate physical facilities to house the computer, and better provisions, such as open shop work area and parking facilities for transient users.	Currently, the centralized computer facilities are housed in an old warehouse with inadequate rain protection and environmental control. Potentially dangerous situations exist in that liquid fire sprinklers - whose use could destroy literally millions of dollars worth of equipment, and exposed cables that are a potential source of serious personnel injury, require replacement. To all intents and purposes, parking facilities for transient users are non-existent, and a great deal of time must be wasted in walking to the facility.

TABLE 2-15

CONSOLIDATED QUALITATIVE DIGITAL COMPUTATION REQUIREMENTS (CONT'D)

Item Number	Number of Mentions	Requirements	Justification/Reason
9	No mention by users but requirement is considered to exist.	Centralized computer facility support for automation of STINFO.	The large quantity of technical information being developed under Government support makes the effective meeting of DOD requirements imposed by the STINFO directive virtually impossible without resorting to computerized information storage and retrieval operations.
10	No mention by users but requirement is considered to exist.	Central computer facility support of the technical reference facility.	While the STINFO program concerns itself with documents produced as a result of Government supported activity, a much larger amount of scientific and technical information is produced by universities and industry under their own sponsorship. This information appears in professional journals and periodicals, patent applications and doctoral and master's theses. Pressures are currently being exerted to have these reports conform to the standards necessary for computerized indexing and storage of abstracts, similar to that being carried out for Government documents under the STINFO program.
11	8	A greater requirement for computer usage will be placed on the centralized facility than indicated by projections of current users as the knowledge of the utility of the facility becomes more general.	There will be significant increase in computer usage to assist management/administrative functions that are currently either not done or done manually. New and more useful test facilities above and beyond those currently planned will come into being, resulting in a greater demand for computer usage. The current trend toward easier-to-use specialized programming languages and the use of computers for non-numerical data manipulation, such as their use to perform deductive reasoning, will result in greater usage.
12	5	General purpose computers, located at the individual laboratories, and satellited to the central facility via the high-speed (wideband) data link.	*No justifiable requirements for such a facility could be ascertained from the information made available. To be justifiable, it is felt that such a requirement must arise from the need to transmit a large quantity of data in a very short time, that a sufficient loading exists at the individual facility to warrant duplication of the centralized facilities. It must be emphasized that a justifiable requirement for large quantities of calculations can exist, but that this in itself does not warrant placing the capability to meet the requirements at the individual facilities instead of at the more efficient centralized facility.
13	1	Central computer facility support of Department of Defense Documentation Center Field Office at Wright-Patterson Air Force Base.	No justifiable requirements for such usage of centralized facilities could be established. Current DOD policy is to have computerized information and storage retrieval concentrated in the Washington office, with the field offices acting primarily as depositories of microfiche copy of the documents.

*The Central facility will be designed so that this requirement can be accommodated at a later date if it is justified.

anticipated number of hours that would be required by a large general purpose digital computer. In addition, three auxiliary parameters which affect the configuration of the computer facility in terms of accessibility, local versus central facilities, and total computing capacity were obtained.

- Turnaround - This is the length of time a user can afford to wait for the results of his computation after the problem has been given to the computer activity.

- Computer Load Distribution - This refers to the computer usage as a function of time. It is important to know how much of the load occurs in peaks at predictable times.

- Programming Method - The user can (1) program the problem himself - "open-shop" programming, (2) he can have the program written by personnel attached to the centralized facility - "closed-shop" programming, or (3) he can have his program written off-base by a contractor, and have the actual computation done at this centralized facility.

By obtaining projections for the values of these parameters in the 1970-1975 time period, and analyzing these in the light of the information contained in the historical records, it is possible to obtain an estimate of the size and type of computer facility that would fulfill these requirements. This gross estimate can then be refined in accordance with the qualitative requirements that have been obtained from the users, modified by judgment based on the type of activity carried out in Area "B", and knowledge of the trends in computer hardware and software.

The participating organizations in Area "B" are projecting a significant increase in computer use over the next ten years. This increase results from two factors: increasing use by present users, and an increase in the number of users. Figure 2-6 shows both of these components; the solid line shows the number of computer hours projected by the current users, while the dashed line is the total estimated use of both present and new users.

Perhaps the most significant feature of the projected usage is the large increase projected over the next few years. During this time period, the needs for adequate computer capability will become critical, and if not met, will detract significantly from Area "B"'s ability to accomplish its mission.

The solid line displays a relatively rapid growth for the first few years, followed by a gradual levelling off. This is

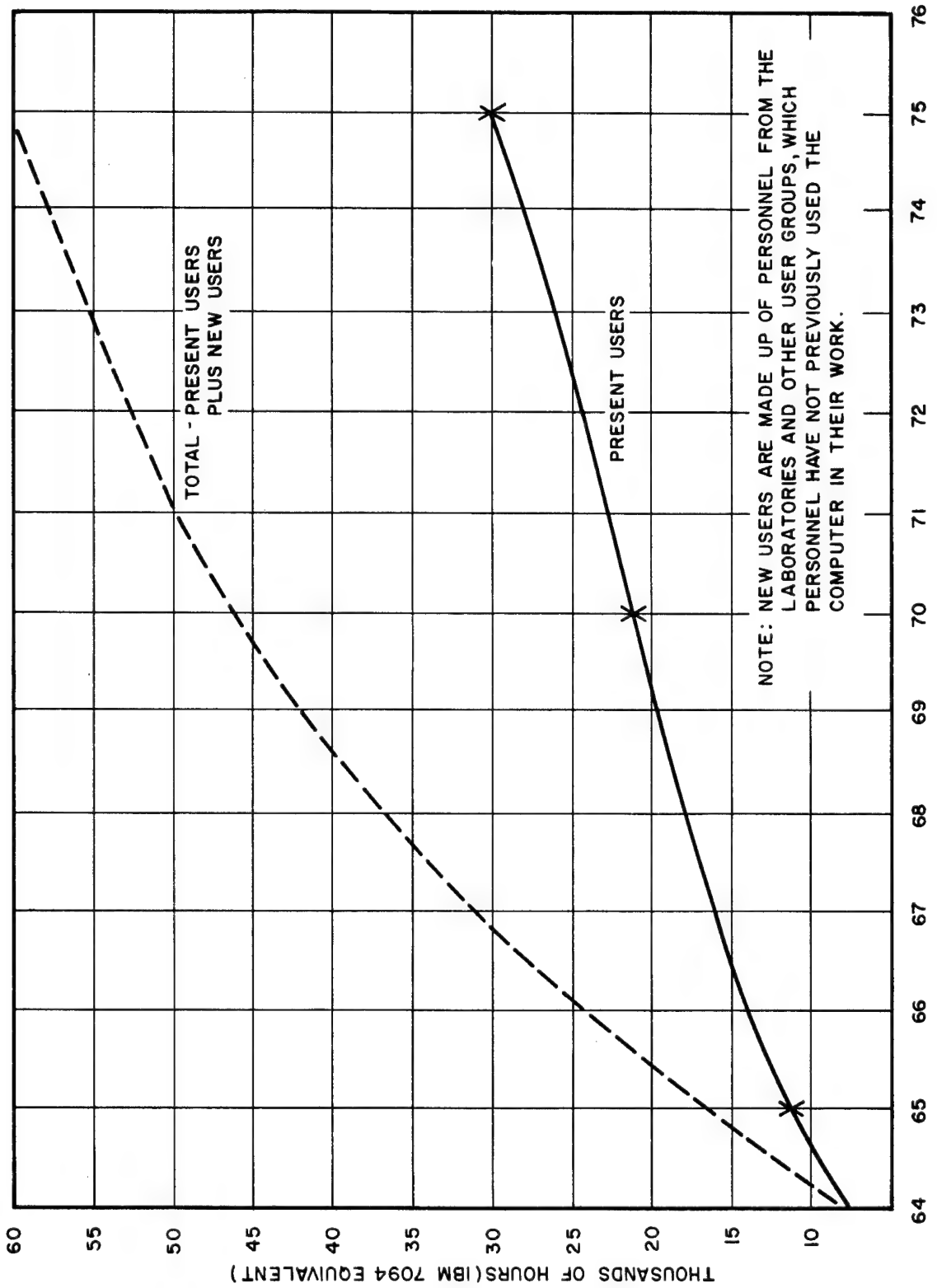

Figure 2-6. Projected Digital Computer Use

entirely in keeping with the available historical data, which show that use has increased at a rapid rate over the last few years. These same data also show that computer use has been distinctly limited by the computational capacity available - new increments of capacity have been rapidly saturated. Eventually, however, it can be expected that an optimum use will be achieved, and the rate of increase will level off to a value related to the increases in workload.

The dashed line - total use - is a conservative estimate based on the following assumptions:

- There would be no significant change in the number of scientific, technical and management personnel in Area "B" over the next ten years.
- The present rate of growth of users - averaging 21 per month - would continue until at least one-third of the Area "B" personnel are regular computer users.
- On the average, the new users would use the computer at least as much as the present users.

The use projected for 1975 of approximately 60,000 hours of present day high-speed general-purpose digital computer time would require more than 10 such computers operating on a three-shift basis.

Turnaround is a function of the capacity of the computer, of the length of time it takes a user to have his data entered into the computer, and the time necessary to bring the results back to his working area where they can be usefully applied. Typically, in a project involving basic research, such as some carried out in the Materials Laboratory, the scientist is exploring several parallel avenues, and if one of these requires the use of a computer, he can wait a reasonable length of time for his results, and can make effective use of the intervening time on other aspects of his problem. This is also true where, for example, specialized data reduction gear is used to reduce the results of large scale tests - such as is done in the Flight Dynamics Laboratory -- so that the experimenter has a "quick look" at the results and can proceed while the computer is carrying out a detailed analysis of the results. On the other hand, on-line usage of the computer often requires that the results be available in real time. Real time, of course, must always be defined in the terms of the response time of the system under control, and may vary from microseconds for a weapon control system to minutes for a psychological research project involving complex human reactions.

Table 2-16 gives the projected consolidated turnaround requirements for Area "B" users in the 1975 time frame.

TABLE 2-16

PROJECTED TURNAROUND REQUIREMENT

Class	% of Computer Usage (1975)
Results needed immediately (including on-line/real-time)	9%
Results needed the same day	49%
Results needed as soon as practical but user can wait at least a day	42%

As shown in Table 2-16, turnaround requirements were stated as the percentage of the projected computer usage that fell in each of the classes shown. To arrive at the consolidated requirements, each user was requested to estimate the percentage of computer usage in each of the three classes for every system and project currently existing in Area "B". These percentages were then weighted by the amount of computer usage projected for 1975 and averaged to arrive at the consolidated requirements. In those cases where the user either did not or could not estimate the turnaround requirements, the mission and function of the unit were examined and compared with the other elements in Area "B" that had given projections and, based on similarities of function and type of project, a turnaround requirement was assigned.

It is significant to note that in spite of the expected tendency on the part of the user to demand immediate results only 9% of the usage fell into this category. Nearly half of the requirements fell into the category of results needed the same day. This observation suggests that the computation could reasonably be carried out on a shared computer facility if the capacity of this facility were large enough to provide same day service for nearly half of its load. Further, the fact that 58% of the usage would involve either immediate or same day service indicated that the amount of time the user must spend in going from his place of business to the central facility could become a significant factor in preventing his getting the type of service he requires. Hence, this factor will have a good deal of influence on the operational methods proposed for user entry into the central facilities.

The goal of the current centralized facility is to clear out its problem backlog at least by the end of each week. Statistics on actual turnaround performance are not available, but it is clear that if this type of operation is continued

through the 1975 time period, only a relatively small percentage of the users will be completely satisfied with the service they obtain.

The load distribution reflects the demands placed on the computer as a function of time. The projected distribution for 1975 is presented in Table 2-17.

TABLE 2-17

PROJECTED LOAD DISTRIBUTION

Class	% of Computer Usage
Recurring or Predictable	33%
Random	67%

The results presented in Table 2-17 were obtained in the same general manner as those in Table 2-16, Projected Turnaround Requirements. With 67% of the usage occurring at random times, it is possible to conclude that the loading on a centralized facility will have a tendency to even out. However, the fact that 33% of the requirements are recurring or predictable strongly implies a distinct possibility that cresting of peak demands could occur. Some of the management programs executed at the central facility are tied to a calendar in the sense that input data will only be available at a certain time and the results are perishable and must be returned before a fixed time and date if they are to be of any value.

Thus, while the centralized facility can be sized to meet an average load, some reserve backup capacity must be provided so that peak user requirements can be met. These considerations have been factored into the operational plan described in later sections.

Quantitative data on the projected methods of programming that would be used in 1975 were obtained in terms of the percentage of the total programming activity of the reporting unit that would fall into three classes: open-shop, where the user does his own programming; closed-shop, where the programming is done by personnel associated with the centralized facility; and off-base, which includes standard programs such as might be available for STINFO, but consists primarily of contractor programming. Table 2-18 gives the percentage of programming activity in each of these categories as projected for 1975, and as approximated for the present operation.

TABLE 2-18

PROGRAMMING METHODS

	% of Total Activity 1975	Approximate % at present
Open-Shop	52%	35%
Closed-Shop	30%	38%
Off-Base	18%	27%

The data presented for 1975 were obtained in the same general manner as those in the previous tables. The increase in use of open-shop programming is to be expected since the advent of programming pseudo-languages, such as FORTRAN, has made it relatively simple for the user to learn programming. What is surprising, however, is that the projected increase is relatively small. This can be accounted for by several factors; for example, many of the users at Area "B" consider the digital computer as an auxiliary tool in their work, and therefore prefer not to do their own programming as long as competent programmers are available at the central facility. In addition, the normal turnover of personnel continually dilutes the percentage of personnel who are familiar with the operation and programming methods used at the central facility.

A second feature of Table 2-18 is that a decrease is projected in off-base, or contractor, programming. This is contrary to the recent trend at Area "B"; manpower ceilings imposed by DOD, coupled with a continuously increasing workload, has resulted in a general tendency to contract more of the effort. Many of the personnel interviewed expressed concern at the trend to have work done under contract, which they felt could be more efficiently performed by base personnel. In making use of the data on Table 2-18 in projecting the operational plan and facilities concept, this concern was taken into account and less weight placed on this statistic. This is an example of an interpretation of the interview results rather than a simple acceptance of those results.

2.4.4 Analog/Hybrid Facility

Table 2-19 shows the growth in analog computer capability in Building 57.

TABLE 2-19

GROWTH OF ANALOG COMPUTER FACILITY

Year	Size of Analog Computer (Number of operational amplifiers)
1948	16
1949	20
1954	136
1958	512
1964	670

As shown in Figure 2-7, "Trend of Workload", the work in terms of "number of problems" increased approximately four times in five years and has levelled off at what appears to be machine saturation point of approximately 80 problems. Although "number of problems" has been used as a measure of effort, this figure has limited utility, since a long complex problem has the same weight in this chart as a short simple problem. The analog center is operated primarily on a one shift basis. The addition of a second and third shift could increase machine availability. However, with analog computers, the direct involvement of the user is much more essential than is the case with digital computers. The requirement that the user be there on a second or third shift basis could create a tendency in users to avoid applying analog techniques in their work with a resulting lack of thoroughness in the output.

The following factors derived from a study of the records, from interviews with Area "B" analog facility users, and from knowledge of the characteristics of analog computers should be taken into account in developing an operational concept of maximum effectiveness for the proposed Central Computing Facility:

- Machine Limitations - The operational limits of the components of the present system prevent greater usage. There are available today analog computers with fifteen times the bandwidth for better response and expanded dynamic range with remote and automatic scaling.

- Over-all System Limitations - The restricted availability of the present system for real-time, on-line problems and the lengthy setup and debugging period prevents a higher problem turn-over rate. This can

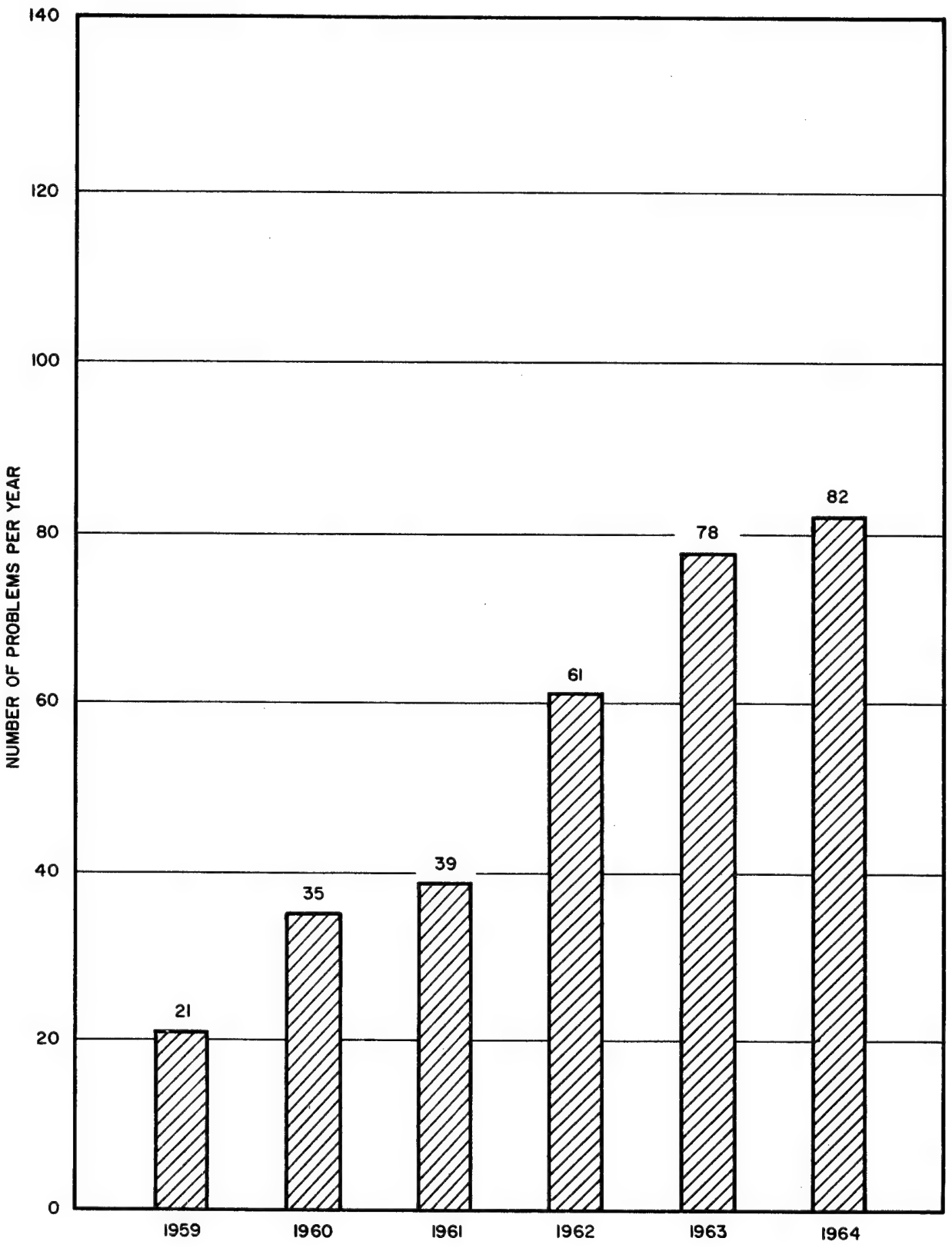

Figure 2-7. Trend of Workload - Analog Computation Division

be partially alleviated by use of hybrid computer systems which are in existence today. A large hybrid installation is being operated in Huntsville, Alabama, and is being used to handle problems of types similar to those as stated in the missions of Area "B" organizations.

- User Limitations - Records indicate that less than 5% of the scientific and engineering personnel are using the present facility. The user organization distribution as shown on Table 2-20, further indicates the

TABLE 2-20

1964 ANALOG COMPUTER WORKLOAD

Organization	No. of Problems	% Support Man Hours*
RTD/Avionics Laboratory	5	2
RTD/Aero Propulsion Laboratory	1	1
RTD/Flight Dynamics Laboratory	16	11
RTD/Materials Laboratory	7	3
RTD/Systems Engineering Group	32	57
Aerospace Medical Research Lab	4	10
Aerospace System Division	1	2
Air Force Institute of Tech.	8	7
Aeronautical Research Laboratory	7	5
Defense Documentation Center	0	0
Foreign Technology Division	0	0
Technology Library	0	0
Others	1	2
TOTAL	82	100

*This column represents the percentage of the supporting personnel in the analog computer center used by each user during 1964.

laboratories in Area "B" are not realizing the full potential of a centralized analog computer facility. This can be attributed partly to lack of understanding by many potential users of the machine's utility and application and partly to the awkwardness of access of the present facility due to such features as location and difficulty of parking. The use of the analog facility has increased significantly after instruction courses on its use but until now the location and parking problems have not been amenable to solution.

The present and projected usage of the R&T Center analog/hybrid computer facility is presented in Figure 2-8. The basis of the prediction is threefold: (1) as a minimum, the requirement for future analog computation will be at least equal to today's requirements; (2) the present analog computer will be upgraded to have wider bandwidth, greater dynamic range, and automatic scaling resulting in a workload twice that of today; (3) as a hybrid system is incorporated the workload will again double. The later projection is consolidated as shown in Table 2-21.

TABLE 2-21

CONSOLIDATED GROWTH PROJECTION

Year	Operational Amplifier - Hours*	Number of Problems
Present	1.3×10^6	80
1970	2.0×10^6	160
1975	2.7×10^6	320

*Number of amplifiers times the number of hours used.

2.4.5 Space Requirements for Central Computing Facility

The detailed requirements developed in the previous subsections lead to the space requirements summarized in Table 2-22. Table 2-22 summarizes by broad function the space requirements for the centralized computer facility. The column headed "General" is provided for the administrative functions carried out by the Directorate of Computations, while the other two columns summarize the space required to carry out digital computation, and the analog/hybrid computation. The area assigned to personnel includes all administrative and operational personnel, with the exception of the computer operators and maintenance

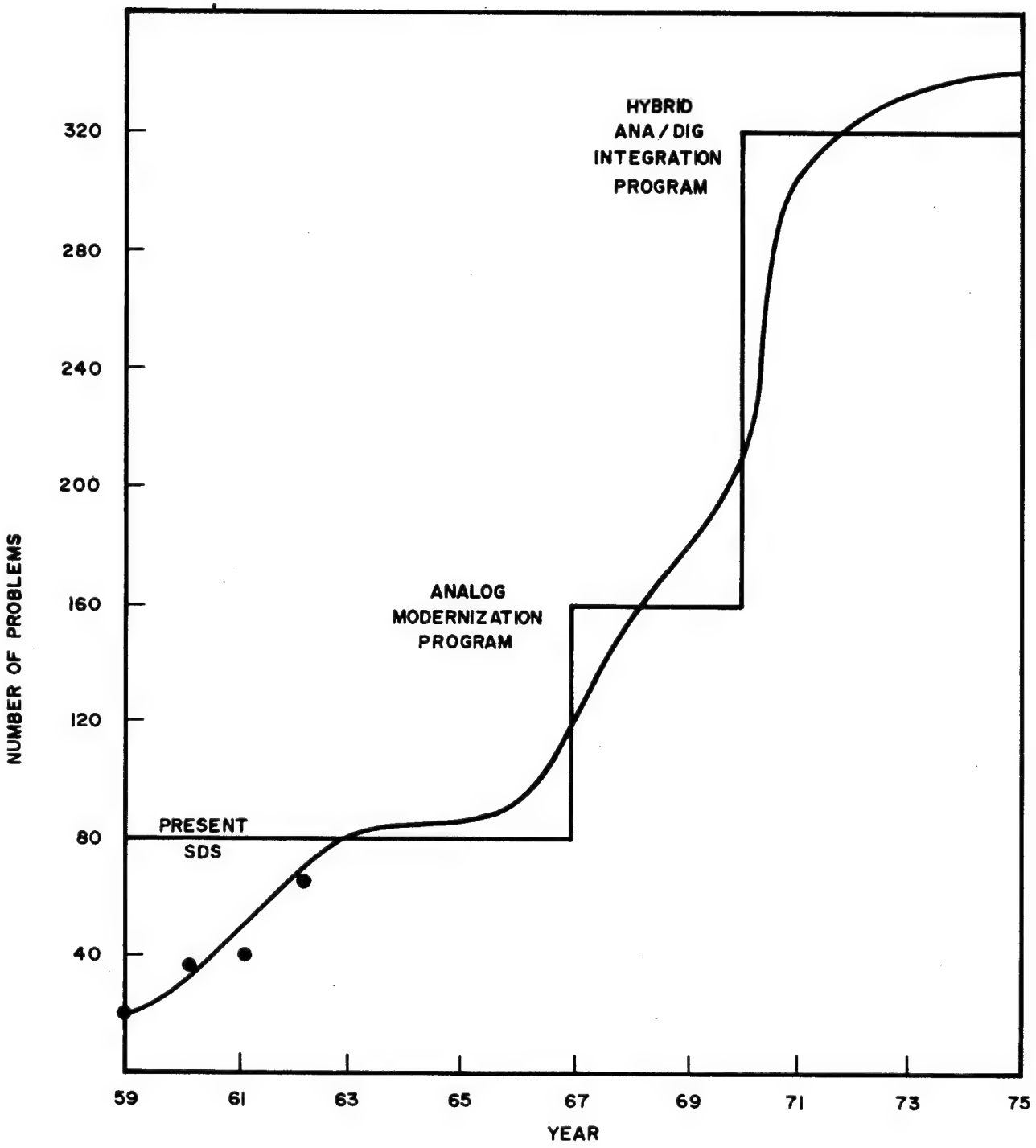

Figure 2-8. Area "B" Analog/Hybrid Growth

TABLE 2-22

SUMMARY OF CENTRAL COMPUTER FACILITY SPACE REQUIREMENTS
(Square Footage)

Primary Function	General	Digital Computation	Analog/Hybrid Computation	Totals
Personnel	1250	12,125	4,250	17,625
Data Processing Equipment	---	8,000	4,000	12,000
Support	--	3,800	3,800	7,600
Subtotals	1250	23,925	12,050	37,225
Hallways, etc. (12%)				4,375
TOTAL				41,600

personnel, who will be housed in the area with the equipment. Support functions include such items as maintenance space, storage areas, communications terminals and space provided for simulation equipment to be housed at the central facility. A nominal factor of 12% has been assigned to rest rooms, hallways and other space required for traffic.

The present central computer facility occupies approximately 30,000 square feet of floor space, so that the projected space represents an increase of approximately 38%. In view of the fact that the overall requirements placed on the computer facility are expected to increase greatly - the use of digital computers, for example, will increase over 400%, - this is a modest increase. The basic reasons why the space requirement can be held to these limits are:

- More efficient utilization of space: Since the facility is being specifically designed to carry out well-defined functions whose interrelationships are known, it is possible to make optimum use of space.

- Sharing of similar functions between the analog/hybrid and digital computation areas: To a large degree, such space as maintenance area, communication terminals, simulator area, and power distribution centers can be shared between the two computation centers.

- The current trend toward smaller equipment: Currently, at least one major computer manufacturer has introduced integrated electronics in central processors. Although microminiaturization will reduce space requirements, it has now become evident that the major advantage lies in increased reliability and decreased production costs. Thus, the space savings will very likely be achieved without any overall additional cost to the user.

- Increased programming efficiency: This trend results in fewer manually produced program steps for machine computation. The two major trends contributing to this are: one toward more simplified, easier to use and learn programming languages, and a continuing effort to have the computer assist directly in the program writing and debugging process.

Space is provided within the centralized facilities for the overall management and administrative functions associated with the operation of a centralized computer facility. The component size and reasons behind selection of the size are shown in Table 2-23.

Within the digital computation division, space can be categorized by its use for personnel, for the computer and peripheral equipment, and maintenance and support. The first two are presented in this section - support spaces are generally shared with the analog/hybrid computation division and will be discussed in a later paragraph.

Personnel space is provided for permanent residents such as managerial/administrative, operational personnel - programmers, analysts, and key punch operators - and for transient users, primarily consisting of user personnel who are either consulting with the analysts and programmers or are carrying out open-shop programming. Space for computer operators and maintenance personnel has been included in the facilities provided for the equipment. Table 2-24 summarizes the personnel space and the reasoning behind the determination of space requirement.

In order to arrive at the projected space requirements for the data processing equipment in the central digital computer facility, a number of complex factors and trends had to be balanced off so that the space provided would be adequate to house the present equipment, would provide for possible future expansion beyond 1975, and yet would not be excessive by normal standards. The major factors and trends contributing to the selection of space are discussed below.

A first factor is the continuing trend in digital computers toward a higher through-put speed -- measured as the results

TABLE 2-23

GENERAL ADMINISTRATIVE PERSONNEL SPACE REQUIREMENTS

Function	Number of Pers.	Sq. Ft. Per Person	Total Area	Justification
Executive/ Managerial	2	200	400	The unique characteristics of centralized computer require an executive at the director level, assisted by an assistant director, who will handle daily operational details and act for the director in his absence. The size of the space was established on the basis that, at this level, it is necessary to meet with a number of people in order to carry out the executive/managerial function.
Administrative Staff	5	100	500	Space includes secretary, clerical and administrative personnel. The functions carried out include personnel management, security, mail distribution and messenger service, supply requisition accounting, and the normal planning and programming functions associated with operating a facility of this size.
Files and Space	0	0	50	- - -
Conference	30	10	300	For staff meetings, briefings, and general conferences usage by all elements of the centralized computer facility. Conferences with attendance greater than 30 can be held in the larger rooms available, (conference facility) in the same building.

TABLE 2-24

SPACE REQUIREMENTS FOR DIGITAL COMPUTER PERSONNEL

Function	Number of Pers.	Sq. Ft. Per Person	Total Area	Reason
Managerial	2	175	350	Provides space for Division and Assistant Division Chief with enough space for them to meet with groups as necessary in order to carry out their function.
Administrative	3	100	300	Includes secretary and clerical help necessary to carry out administrative functions.
Conference Facilities	60	10	600	Three 20-man conference rooms provided. One will be utilized primarily as classroom for orientation and training of open shop users, the other two to be located near the operational personnel and used for meetings and briefings.
Space for Open Shop Programming	15	100	1500	Currently spaces are provided at the Center facility for 25 personnel during open shop programming. With the increase in computer use, there would normally be a need for additional rather than decreased open shop programming, and this need should be further increased by the trend toward open shop usage in the future. However, two factors combine to reduce these requirements - the increased efficiency in programming methods which will require less time to do the programming and the existence of remote access stations - it is expected that 80% of open shop programming is to be done at the user location.
Programmers and Math Technicians	10 50	125 100	1250 5000	Included is extra space for ten senior programmers who must supervise other programmers, and meet with customers. Includes closed shop programmers, programmers who assist open shop users and contractors, and programmers who maintain software systems.
Analyst	12	125	1500	The number of analysts has increased in direct proportion to the increase of programmers, whom they normally support.
Open Shop Key Punch	2	100	200	This space is provided so that user personnel during open shop programming and contractors using the computer can punch cards themselves - this is particularly useful during program de-bugging.
Production Key Punching	21	50	1050	Space for production key-punching associated with closed shop programming has not been increased linearly with increased computer usage for two reasons. It is anticipated that there will be increased use of magnetic tape to record results from facilities, allowing this data to be entered directly into the computer; secondly, those facilities with their own computer will do their own production key-punching.
Key Punch Supplies	-	-	75	Space is provided for daily operating supplies, such as cards, input sheets, etc., needed in the key-punch operations.
Supervisory	2	125	250	First level supervision for programmers and analysts.

delivered per unit time of computation on a standard or uniform problem mix -- with an accompanying decrease in the size and number of equipments needed to achieve the through-put. At least three factors contribute to this trend:

- Increased Efficiency. Modern digital computers have a high degree of inherent system flexibility, so that future computer installations can be more closely tailored to the problem mix they will have to handle.

- Increased Operating Speeds. Conservatively, increases in operating speeds of an order of magnitude for all computer components -- input/output devices, central processors, and memory units -- can be anticipated. However, the increase of through-put will depend on such factors as problem mix and system efficiency.

- Decrease in Size. The purely electronic portions of the equipment can be reduced in size through the use of integrated circuits, but in general this will not be true of the mechanical components. Some mechanical components such as line printers, however, can be replaced by electronic units whose increase in speed gives the equivalent of a size reduction.

The central computer will be shared by a large number of users, and therefore must consist of a multiplicity of central processors, so that programs can be run simultaneously for a number of users. There will be, therefore, a number of essentially physically separate central processors and equipment to carry out the executive control and operation of the multiprocessor. Further, the fact that only a small percentage -- currently estimated at 5-10% of the problems - have a security classification means that some portion of the equipment should be capable of being secured and set aside to handle these, while the remaining multiprocessors are used on unclassified problems.

Finally, it must be kept in mind that, if the present schedule is maintained, the facility will be ready for occupancy in the late 60's, and must accommodate equipment that will be available at that time.

In assessing the effect of all these factors, the major conclusion reached was that the basis for selecting space requirements should be the "third generation" computers, which will be utilized in the 1970-75 time period. If the scientific and technical community at Area "B" remains at its present size, the growth of the computer usage will eventually level off and these equipments will be adequate to meet the computational requirements. If, on the other hand, the number of personnel

increases, it can be expected that the need for computers will also increase beyond what has been projected for 1975. In the judgement of the contractor, such additional increases in computer requirements will be offset, to a large degree, by the decrease in size of computer components, over the next 20 to 30 years.

With the foregoing considerations in mind, Table 2-25 was constructed to show how space requirements for the data processing equipment were estimated. As shown in the first column - Functional Area - the overall equipment space has been divided into three groupings: a main computer room that contains the major elements of the computer facility, a secondary computer room that contains enough equipment to allow a portion of the computational capability to be used on classified problems, and a third area for card handling equipment not normally used on-line with the computer. The second column lists the type of equipment by generic designation -- work space is provided for operational personnel within the same area that contains the equipment. The next column tells how many units of equipment are provided, followed by a column indicating the square footage of floor area required by each unit. The next column then simply gives the extension of the number of equipments times the floor space per equipment. Explanatory remarks are included in order to clarify the choice of equipment and space allotment.

With the analog/hybrid computation division, the space can be categorized by its use for personnel, for the computer and peripheral equipment, and for maintenance and support: Personnel space is provided for permanent residents such as managerial/administrative, operational personnel programmers, and analysts and for transient users consisting of user personnel who are consulting with the analyst and programmers, carrying out openshop programming or monitoring simulation tests. Space for the computer operators and maintenance personnel has been included in the facilities provided for the equipment. Table 2-26 summarizes the personnel space requirements.

The space requirement for the analog/hybrid computer systems is expected to remain constant at 4,000 square feet. Although the computational workload is estimated to increase by a factor of four, the more efficient machine organization and operation as well as volumetric compression of components with greater operational capability, will be able to make more effective use of the allocated space. The machine space will be divided as shown on Table 2-27.

TABLE 2-25

SPACE REQUIREMENTS FOR DIGITAL EQUIPMENT

Functional Area	Type of Equipment	No. of Equipment	Floor Space per Equipt. (sq.ft.)	Total Floor Space (sq.ft.)	Remarks
Main Room Computer (Rm #1)	Central Processors	3	500	1500	Two installed initially, expansion space provided for third unit by 1975.
	Input/Output Processors	2	400	800	Assumes 20% of I/O processing will be done at remote access stations.
	Random Access Memories	6	200	1200	Two installed initially, expansion provided for two more by 1975.
	Magnetic Tape Units & Controls	12	75	900	- - -
	Remote Access & Satellite Computer Control Processor	1	400	400	Includes Data Transmission terminals
	Operator's Console	2	100	200	One for monitoring remote access, one for remainder.
	Card Reader/ Punch	3	100	300	Assumes 50% of card handling and output printing done at remote stations.
	Output Printers	2	150	300	- - -
	Electronic Inquiry Equipment	1	100	100	- - -
	Electronic Printer/Plotter	1	300	300	- - -
	Desk Space for Operators	-	-	500	To be shared by all operators as work area.
SUBTOTAL				6500	
Classified Computer Area (Rm #2)	Central Processor	1	400	400	The equipment in this area to be used for classified problems and as backup to the main computer.
	Input/Output Processor	1	300	300	
	Random Access Memory	1	150	150	
	Card Reader/ Punch	1	100	100	
	Output Printer	1	100	100	
	Console	1	100	100	
	Magnetic Tape Units/Controls	3	75	225	
	Desk Space for Operator(s)	-	-	125	
SUBTOTAL				1500	
Card Equipment	Card Sorter	1	150	150	This area to be used for off-line equipment.
	Card Duplicator/ Merger	2	100	200	
	Punch Tape to Card Converter	1	150	150	
SUBTOTAL				500	
GRAND TOTAL				8500	

TABLE 2-26

ANALOG/HYBRID PERSONNEL SPACE REQUIREMENTS

Function	Number of Pers.	Sq. Ft. Per Person	Total Area	Rationale
Managerial	2	175	350	Provides space for Division and Assistant Division Chiefs with enough space for them to meet with groups as necessary in order to carry out their functions.
Administrative	2	125	250	Includes secretary and clerical help necessary to carry out administrative functions.
Conference Facilities	40	10	400	Two - 20-man conference rooms provided. One will be used by the Division Chief and the other will be located near the operational personnel for meetings and briefings. Secondary usage will be for use as classroom for orientation and training of open shop users.
Space For Open Shop Programming	4	100	400	Space provided for use by open shop personnel while at the computer center.
Programmers Work Area	14	100	1400	Two-man office space for use by programming staff.
Programmers Office	4	100	400	Individual office space to be used by senior programmers.
Analyst Office	6	125	750	Problem analyst to support the methodology of analog/hybrid computer application.
Supervisory	2	125	250	First level supervision of programmers and analyst.
Supplies	0	0	50	Space for daily operating supplies.

TABLE 2-27

ANALOG/HYBRID COMPUTER SPACE REQUIREMENTS

Functional Area	Floor Space (Sq.Ft.)	Remarks
Analog Computer Room	2500	Space to initially accept the present SDS computer and I/O equipments and for eventually upgraded equipment.
Hybrid Computer Room	1500	Space to initially accept the present EAI computer and eventually to contain the hybrid computer.

The support space for the Centralized Computer Facility will generally contain components that will not be significantly reduced in size over the next ten years; thus, the standards used are those currently used by the computer and communications industry. The one exception is the space for simulator -- this was determined by estimating that, at the most, four small simulators or test setups would be located at the Centralized Facilities at any one time. Larger simulators if used may be located at the user facility and tied to the Centralized Computers via data links.

Table 2-28 gives the individual requirements of the Digital and Analog/Hybrid Computer Facilities for each type of space; the fourth column gives the arithmetic sum of the two. The fifth column gives the estimated savings in space achieved by having Digital and Analog/Hybrid Computation Division share common space. The sixth column gives the required space -- equal to the difference of the previous two columns. The major components contained in each area are given in the Remarks column and form the basis for determination of space required.

TABLE 2-28

CENTRALIZED COMPUTER FACILITY SUPPORT SPACE REQUIREMENTS

Function	Digital (sq.ft.)	Analog/ Hybrid (sq.ft.)	Total (sq.ft.)	Estimated Saving (sq.ft.)	Required (sq.ft.)	Remarks
Maintenance Work Area	800	700	1500	300	1200	Ten personnel @ 150 sq. ft. each.
Maintenance Storage	600	400	1000	200	800	Secure space for test equipment, tools and supplies.
Communications Terminals	800	400	1200	200	1000	Space provided for main and intermediate distribution frames, modems, patch bays and test and monitoring equipment, security equipment and operational personnel.
Simulators	400	400	800	-	800	Four simulators @ 200 sq. ft. each.
Power Distribution	350	300	650	150	500	Space for security equipment (Red/ Black separation), gradual-break power generating and distribution equipment.
SUBTOTAL					4300	
Unclassified Storage	1200	600	1800	200	1600	Cards, printer and plotter supplies, plug boards, and documentation.
Tape Vaults	600	150	750	150	600	Storage for both unused and recorded magnetic tapes.
Component Storage	-	200	200	-	200	For precision components, including plotters and recorders not in use.
Classified Storage	600	500	1100	200	900	All classified documents, including schematics, cards and magnetic tapes.
SUBTOTAL					3300	
GRAND TOTAL			9000	1400	7600	= 15% Savings

SECTION III

FACILITY CONCEPT AND OPERATIONAL PLAN

3.1 RESEARCH AND TECHNOLOGY CENTER - MISSION AND OPERATIONAL CONCEPT IN BRIEF

Mission of the R&T Center Organization

The Research and Technology Center of Area "B", WPAFB, consisting of the central technical reference facilities, the central technical conference facilities, and the central computer facilities and certain other support facilities, has the mission of increasing the overall efficiency and effectiveness of the Area "B" technological complex by functioning as a center for technological coordination and by supplementing the facilities available within the individual user facilities. The supplementary facilities are generally larger and more diverse than any individual user could justify on the basis of his needs taken alone.

As a shared facility, the R&T Center will operate as a cooperatively operated entity. Three of the elements of the Center -- the Central Computational Facility, the Main Library, and the Defense Documentation Center -- already exist and function as centralized service organizations to WPAFB. Thus, while some procedural changes may be required to insure that maximum advantage is taken of collocation in the R&T Center, the basic organizational features required already exist. A nucleus function -- that of coordinating large conferences sponsored by Area"B" organizations -- does exist in ASD under the Director of Master Planning. The experience gained in performing the coordinating functions can be used to insure that an appropriate organizational structure is formed for the R&T Center as an entity.

Operationally the R&T Center organization carries out its mission in three separate and distinct ways:

- Individual Actions - Each of the individual elements of the Center provides services to the Area "B" users.

- Reinforcing Services - Because of collocation in a single building, the individual service elements can reinforce each other to provide superior and unique services. See Table 3-1.

- Coordinating Activities - Because the single R&T Center serves a multiplicity of users, it can become a natural focal point for coordinating activities involving inter-disciplinary efforts.

TABLE 3-1

OPERATIONAL ADVANTAGES OF COLLOCATION OF SERVICE FACILITIES

Cooperating Elements	Comments
Main Technical Library and DDC (Referred to as Technical Reference Facility)	Users seeking reference material can obtain standard text and classified Government reports at one convenient location.
Technical Reference Facility and Central Computing Facility	Collocation of these elements considerably eases the creation of an automated library catalog readily available to all users.
Central Technical Conference Facility and Central Computing Facility	Simplifies problems of running computer training courses. These courses will be required increasingly as use of the computer increases.
Reference Facility, Conferencing Facility, Computing Facility	In commencing and managing large programs requiring close coordination, the orientation can be given in the conferencing facility, the references provided in the libraries, and the joint analytic efforts performed on the computer. Thus the Center serves as the focal point for coordinated efforts.

Figure 3-1 is a site plan of the R&T Center and Figures 3-2 through 3-5 show various views of the R&T Center as it is presently envisioned.

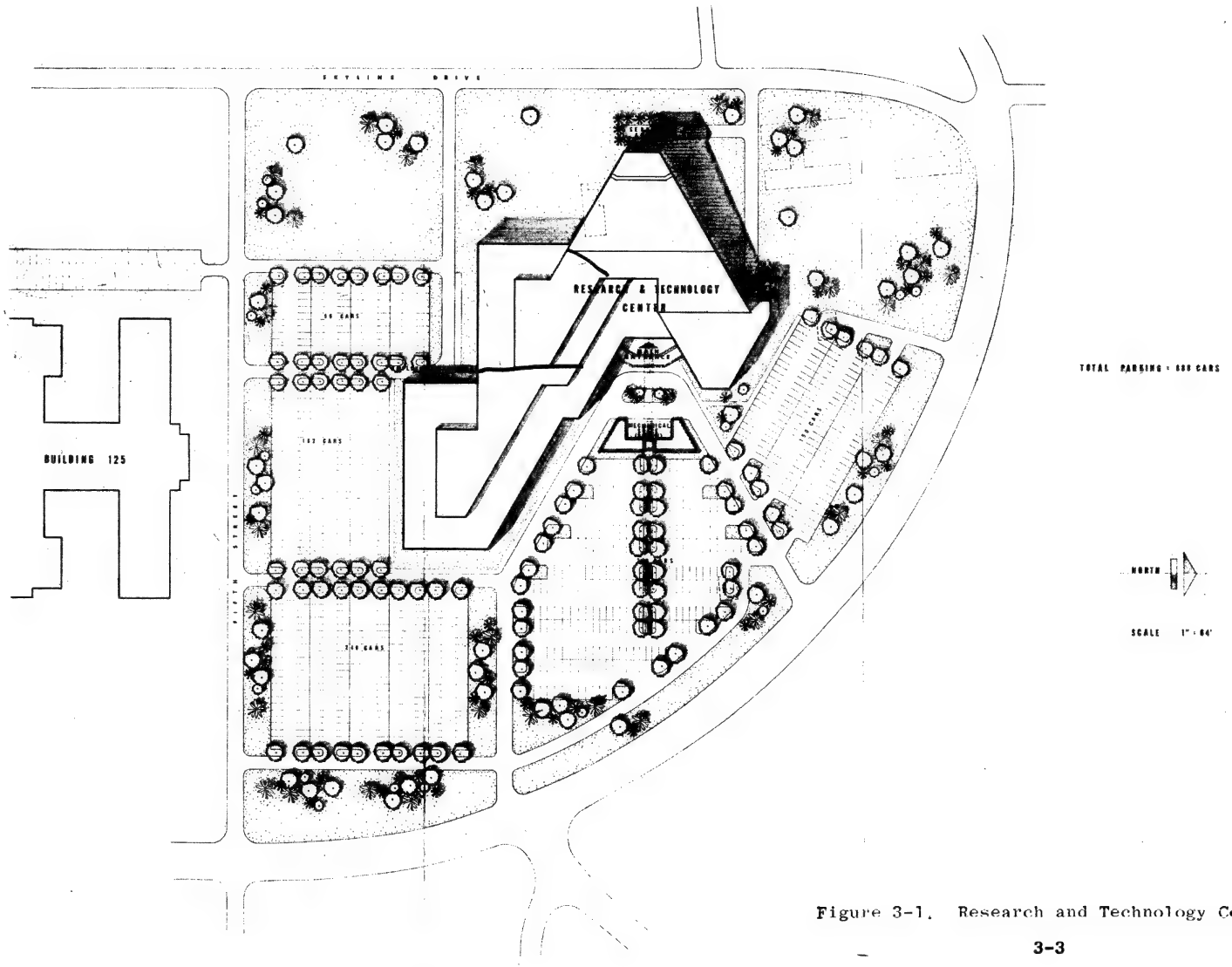

Figure 3-1. Research and Technology Center

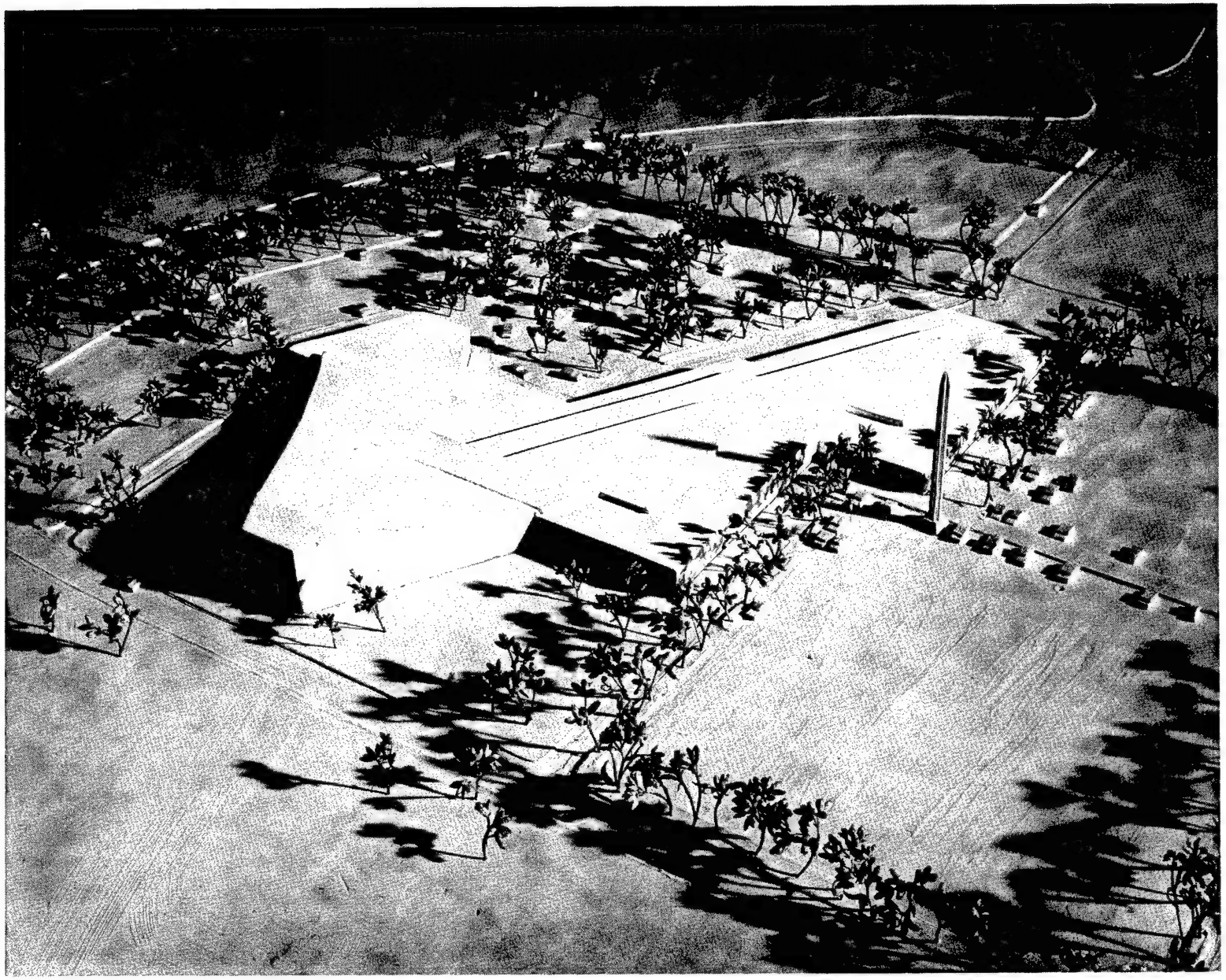

Figure 3-2. Proposed Research and Technology Center

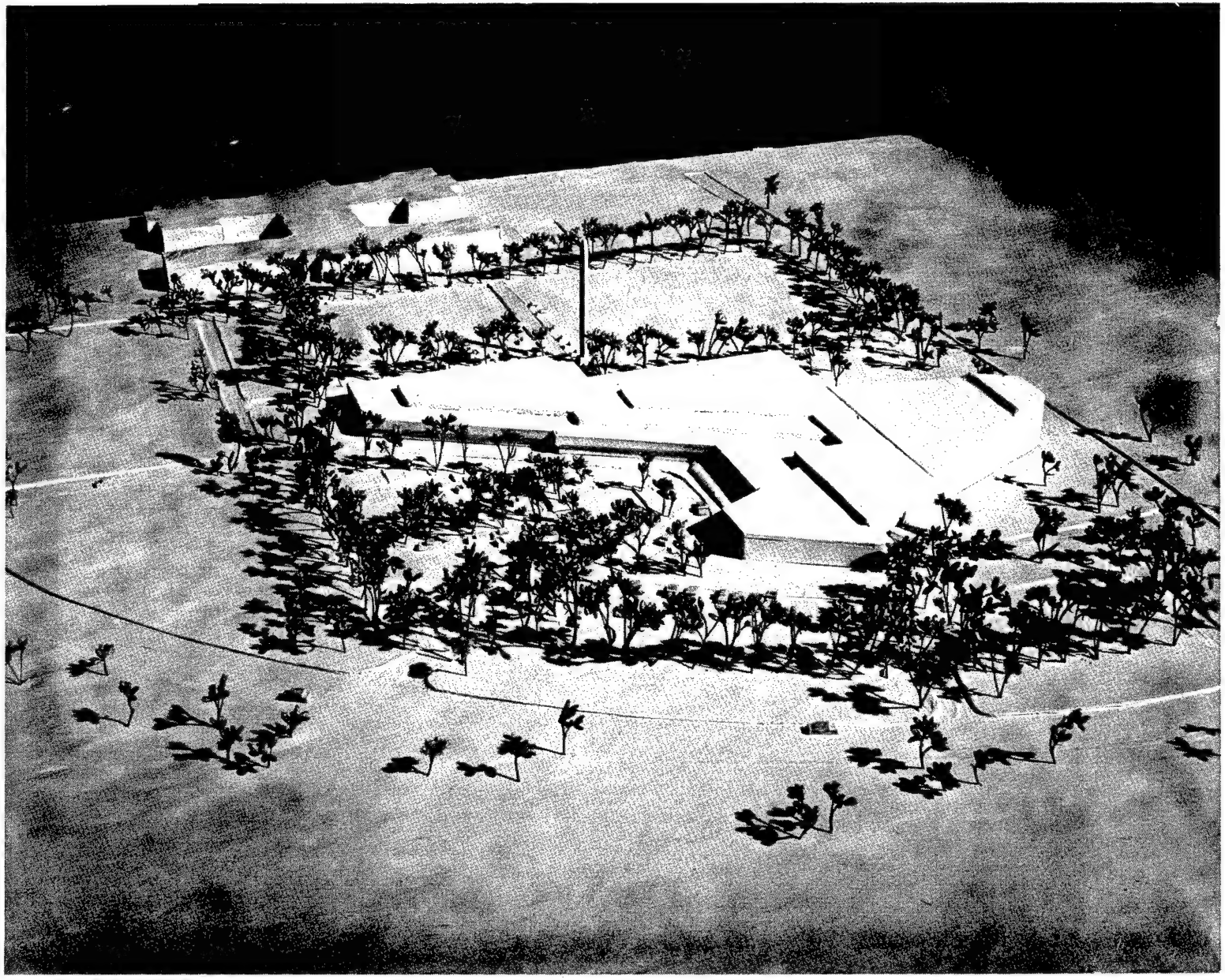

Figure 3-3. Proposed Research and Technology Center

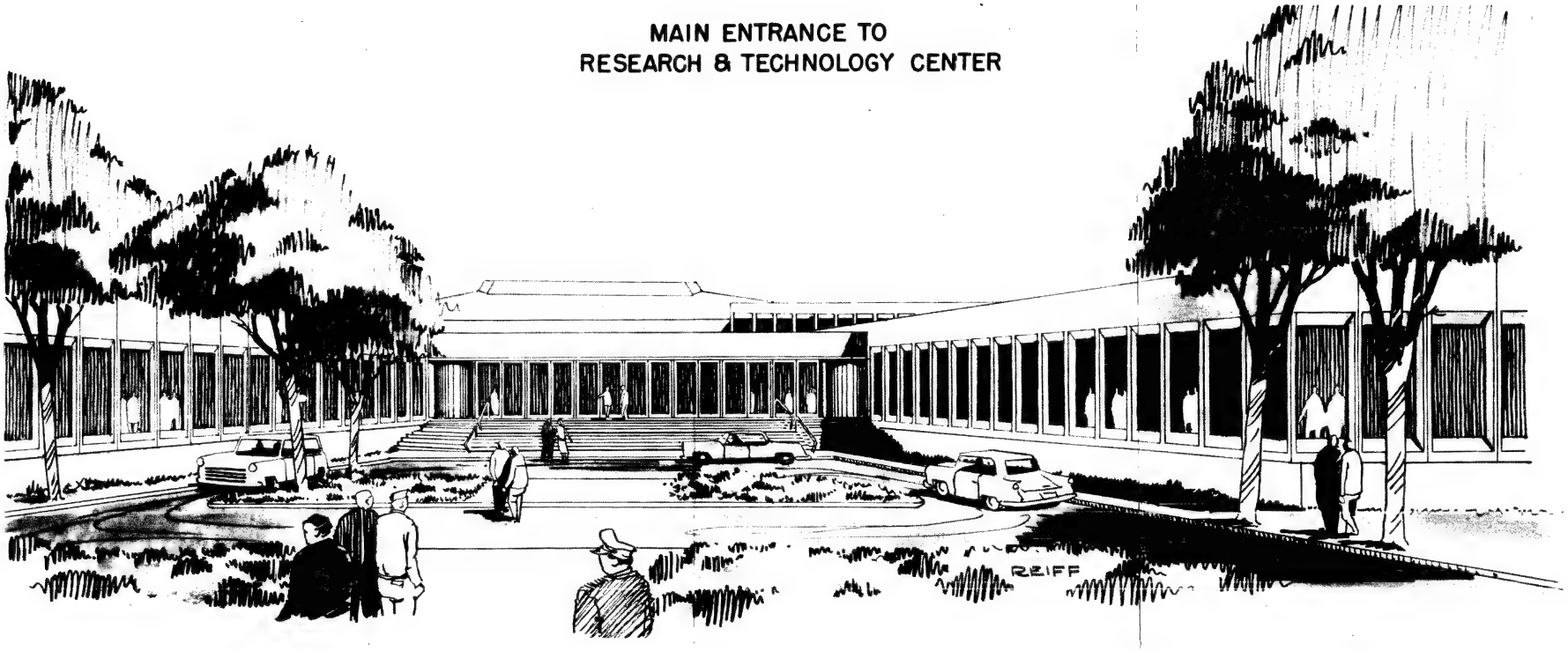

Figure 3-4. Main Entrance to Research and Technology Center

ENTRANCE TO LIBRARY AND COMPUTER FACILITIES

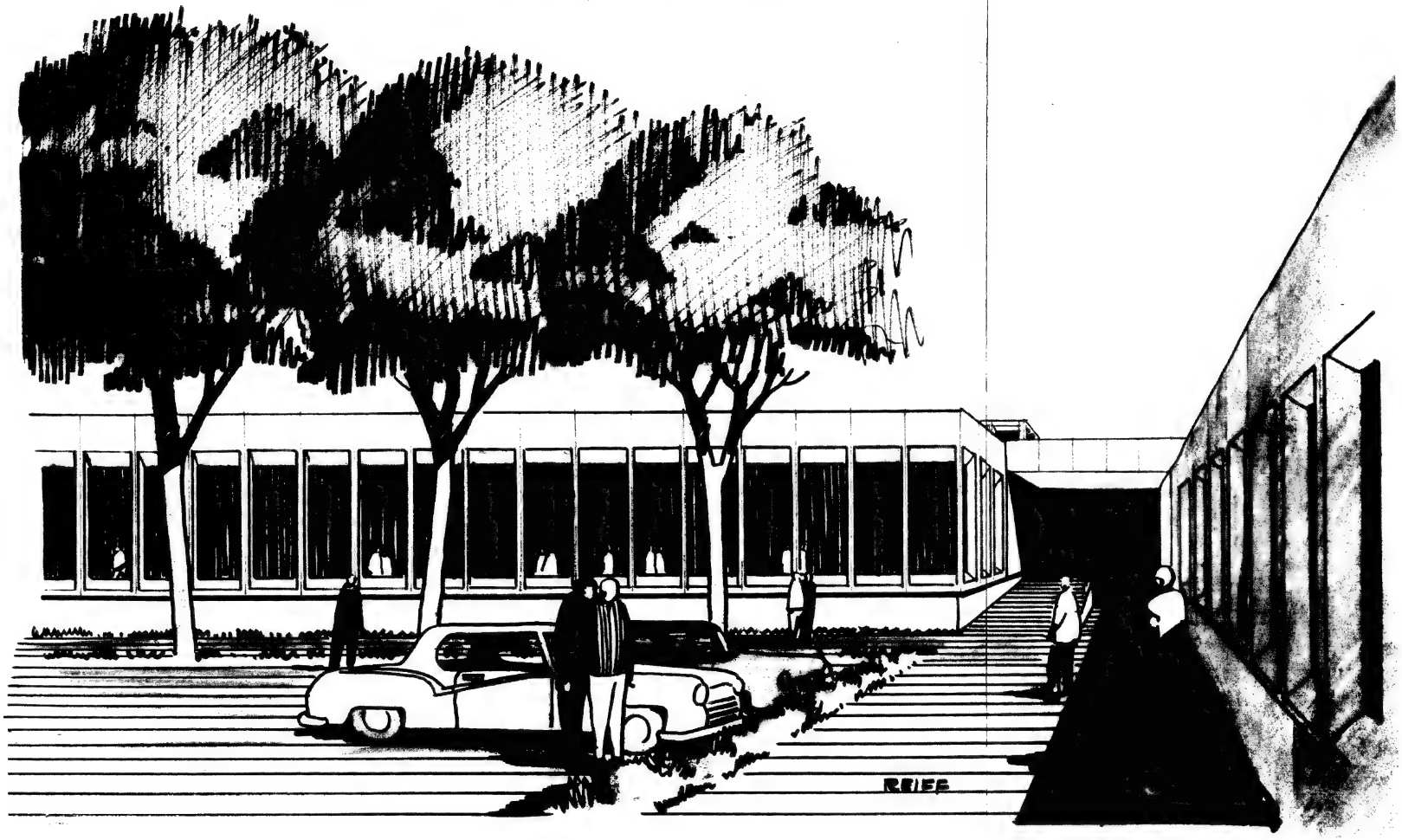

Figure 3-5. Entrance to Library and Computer Facilities

3.2 CENTRAL TECHNICAL REFERENCE FACILITY - MISSION AND OPERATIONAL CONCEPT IN BRIEF

Mission of the Central Technical Reference Facility

The Central Technical Reference Facility of Area "B" , consisting of the Main Technical Library, its branches, and the various Area "B" field libraries and the Defense Documentation Center, has the mission of providing convenient and rapid service in supplying the technical reference services required by Area "B" personnel in support of their work. Specifically, the Central Technical Reference Facility will support the Air Force STINFO program and, through the Central Computing Facility, provide automated reference facilities which are available through data links at the various user facilities.

The Main Library, to be located in the R&T Center, now has, and will continue to have in the 1970-1975 period, branch libraries. The operational procedures by which the Main and Branch Libraries interact are such that, for purposes of this report, they can be considered a single entity. However, in order for this to be true, the physical and operational facilities of the branch libraries must be brought up to the standard of the Main Library if they are going to provide their users with the same high grade of service. The Main Library will be in a position to automate the interchange of information so that, at some time in the future, the scientist, engineer, or manager at WPAFB can readily tap the very large reservoir of information that exists in the libraries of the nation. With the introduction of automation, the exchange of card catalogs and requests for specific literature loans can be processed rapidly and conveniently, increasing the usefulness of the library system.

The major emphasis will therefore be placed on the functional relationships that will exist between the Main Technical Library, DDC, the satellite field libraries, and individual, automated data files that will exist within the user organizations of Area "B", and the STINFO operation. This projected relationship can be summarized as follows:

- By mission and charter, the Main Technical Library and DDC perform non-duplicative services. The Field Office of DDC concentrates on reports produced as a result of DOD sponsored effort, and can call on reports from such non-DOD

Government agencies as the Atomic Energy Commission and National Aeronautics and Space Administration. On the other hand, the Main Library concentrates on general technical literature, produced by industry, universities, professional societies, and individuals.

- The Satellite Field Libraries will have similar holdings to those of the Main Library, i.e., general technical literature, but will concentrate on the highly specialized fields of interest of the laboratory involved. Through the use of common, automated indexes, the individual user will be able to access the holdings of the Main Library and its satellites directly. Thus the general holdings of the Main Library and specialized holdings of the satellites provide a broad and deep collection of references available to all users in Area "B".

- Individual user organization will continue to maintain data files of reports -- primarily produced under Government sponsorship -- that concentrate on highly specialized holdings of interest only to the individual laboratory. General references to these holdings will be available in the automated catalog.

- A further unifying influence that will weld these individual information centers into a cohesive whole is the STINFO operation. Many of the laboratories now have appointed STINFO officers, and in the future all user organizations will have them. The function of the STINFO officer will be to improve the ability of the scientist and engineer to access the literature and avoid duplication of research, and to encourage publication of reports of significant work.

The specific tasks that will be carried out within this operational framework are tabulated by element in Table 3-2. The organizational relationships of these library elements are shown in Table 3-3.

The automated library processing system of the future will permit users from satellite field libraries in individual laboratories to make remote queries and obtain information concerning location and availability of books, documents, and reports. The library itself will use the computer's facility to handle the normal record keeping inherent to the library operations. During the 1975 time period, it is anticipated that most of

TABLE 3-2

OPERATIONAL FUNCTIONS OF ELEMENTS OF THE CENTRAL TECHNICAL REFERENCE FACILITY

Element	Function
Main Technical Library	• Perform centralized processing for main and all satellite libraries, including automation of acquisition and distribution of books and information retrieval. • House extensive holdings of recognized open technical journals. • House extensive holdings of technical books published in the general technical fields of interest to Area "B" personnel. • Maintain an information access center. • Coordinate STINFO activities. • Effect interlibrary loans.
Satellite Library	• House holdings peculiar to the disciplines of the individual user's mission. • House holdings that the user group utilizes on a daily or weekly basis. • House a collocated STINFO office. • Maintain a remote inquiry device for entry into the library processing system.
Defense Documentation Center	• Maintain microfiche copies of DDC holdings. • Assist user in processing requests for literature searches and bibliographies for DDC Washington office.

TABLE 3-3

ORGANIZATIONAL RELATIONSHIP OF ELEMENTS OF THE CENTRAL TECHNICAL REFERENCE FACILITY

Element	Organization & Location
Main Technical Library	Located in the Research and Technology Center.
Defense Documentation Center	Located in the R&T Center and reports to the DDC Headquarters in Washington, D. C.
Satellite Libraries (Branch Libraries)	Located at various points in the Wright-Patterson Air Force Base complex, outside Area "B". These will be organizational extensions of the Main Technical Library at the R&T Center.
Satellite Libraries (Field Libraries)	Located in certain Area "B" laboratories, satellited to the Main Technical Library, but reporting organizationally to the laboratories in which they are located.

the processing associated with the library and technical reference functions will be automated; some typical functions are given in Table 3-4.

Additionally, the advanced library processing system will have a capability of providing a tailored service to laboratories or individual users. As an example, accession lists or abstracts can be tailored, based upon a predetermined profile of interest of the users.

A centralized STINFO office should be collocated with the library to maintain an information access center. This center serves as a focal point for users to determine, on a broad basis, where technical information on specific subjects within technical fields can be found.

The operational concept for the Central Technical Reference Facility in terms of the R&T Center building layout is presented in subsection 3.6. Figure 3-6 pictures the Main Technical Library as seen upon entering it.

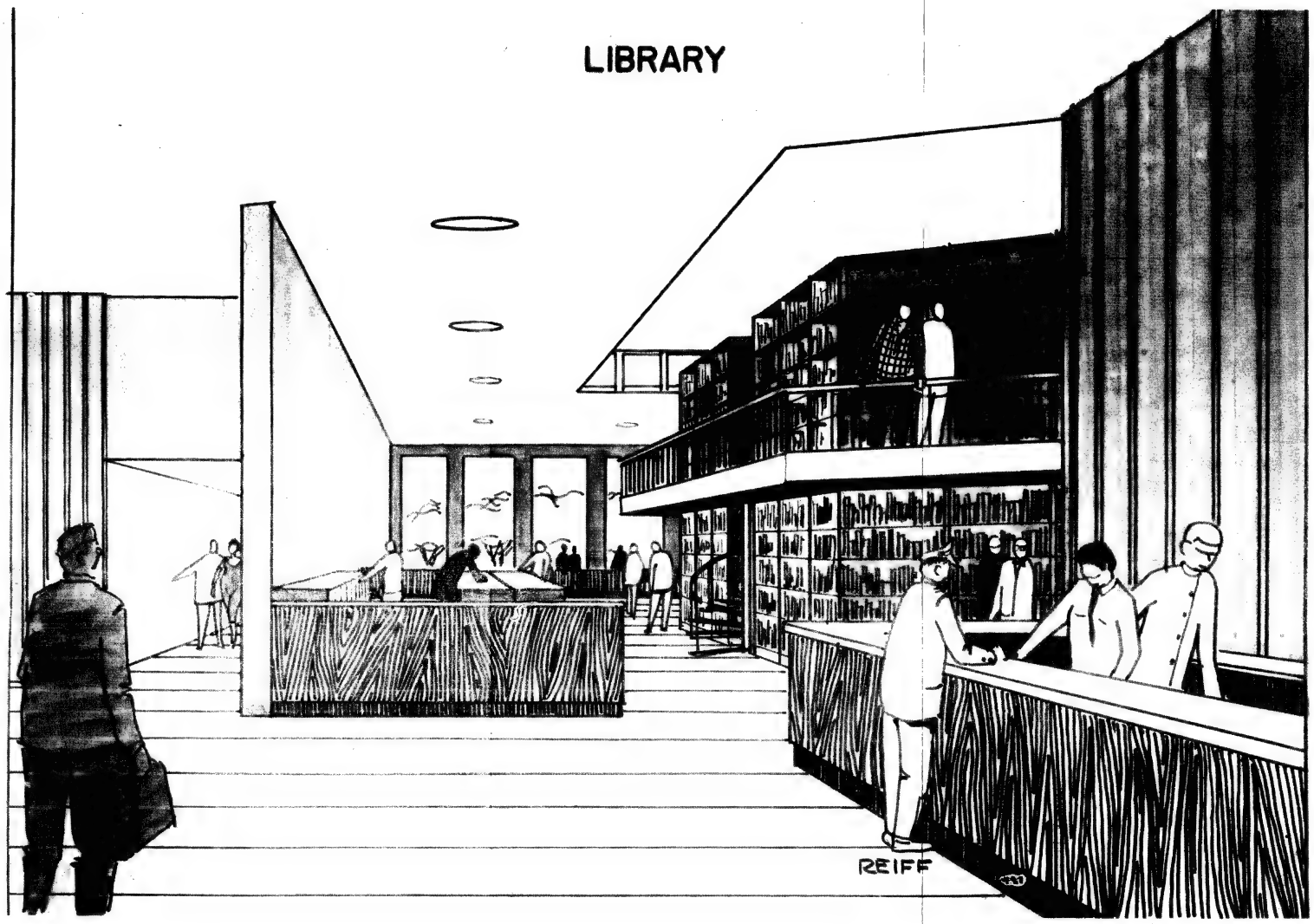

Figure 3-6. Main Technical Library

TABLE 3-4

TYPICAL AUTOMATED LIBRARY PROCESSING FUNCTIONS

Function	Comments
Request Processing	Determine if item is a holding and determine its availability. Process overdue notices. Process interlibrary loans.
Acquisitions	Process items to be ordered; check status of items on order.
Receiving	Process receipt of new items.
Cataloging	Maintain current catalog information.
Subject Retrieval	Retrieval terms matched against inverted file enables many questions to be answered with a single pass through the subject file.

3.3 CENTRAL TECHNICAL CONFERENCING FACILITY - MISSION AND OPERATIONAL CONCEPT IN BRIEF

Mission of the Central Technical Conferencing Facility

The Central Technical Conferencing Facility of Area "B", consisting of a large auditorium and four medium-sized conference rooms together with the necessary audio-visual aids and supporting services, has the mission of providing a convenient and flexible facility to accommodate technical and administrative conferencing requirements within Area "B" WPAFB.

With both a large auditorium and four smaller rooms, which, in turn, can be subdivided, a high degree of flexibility is possible in scheduling the use of the conference facilities. They can all be used for independent meetings, or the smaller rooms can accommodate overflow or exhibits from a single large conference.

The large auditorium will require the conventional support facilities necessary for effective intra-conference room communications, as listed below:

- Large screen projection display -- film, slides
- Closed circuit television from auditorium to conference rooms
- Audio pickup system
- Audio distribution system
- Storage area
- Light controls

One of the smaller conferencing rooms is planned for VIP conferencing and briefings, and will contain a rear-projection display capability. In the future, it will be possible to install a small electronic group dynamic presentation device, coupled to the computers, that will be capable of presenting on-line graphics, tabular, and narrative information from a data base stored in the computers.

For certain support tasks which require little special training (such as assistance in registration), the organization sponsoring the symposium should provide personnel to assist in performing the operational task. However, key operational tasks such as overall scheduling, special arrangements for security and/or VIP's should be provided by the Center Conference Coordinator who is specifically trained in and knowledgeable of the operational tasks.

The following are examples of the type of functions that can be most efficiently performed by laboratory personnel:

- Establish symposium theme and organize sessions
- Issue call for papers
- Review abstracts and manuscripts
- Establish registration procedures
- Publicity

The following is a listing of the operational tasks which can generally be most efficiently handled through coordination with conferencing coordinator:

- Provide and operate audio-visual equipment
- Coordinate security arrangements
- Establish protocol
- Provide escorts
- Maintain conference supplies
- Arrange for transportation as needed
- Provide information services.

The operational concept in terms of building layout is discussed in subsection 3.6. Figures 3-7 and 3-8 present views of the auditorium and a conference room respectively.

3.4 CENTRAL COMPUTER FACILITIES - MISSION AND OPERATIONAL CONCEPT IN BRIEF

Mission of the Central Computer Facilities

The Central Computer Facilities, consisting of an integrated complex of digital, analog, and hybrid computers and the associated operational and administrative personnel, has the mission of providing centralized computational services to the users in Area "B". The services are to be available both at the R&T center and, through remote data links, at the user facilities.

By 1975, the overall requirements for computer use in Area "B" will be met by an integrated complex of computers within Area "B" , and by off-base facilities. The major features of the operational plan are:

- A large, general-purpose digital and analog/hybrid central computer facility that will service the bulk of the requirements. User entry to the computers will be through the following procedures:

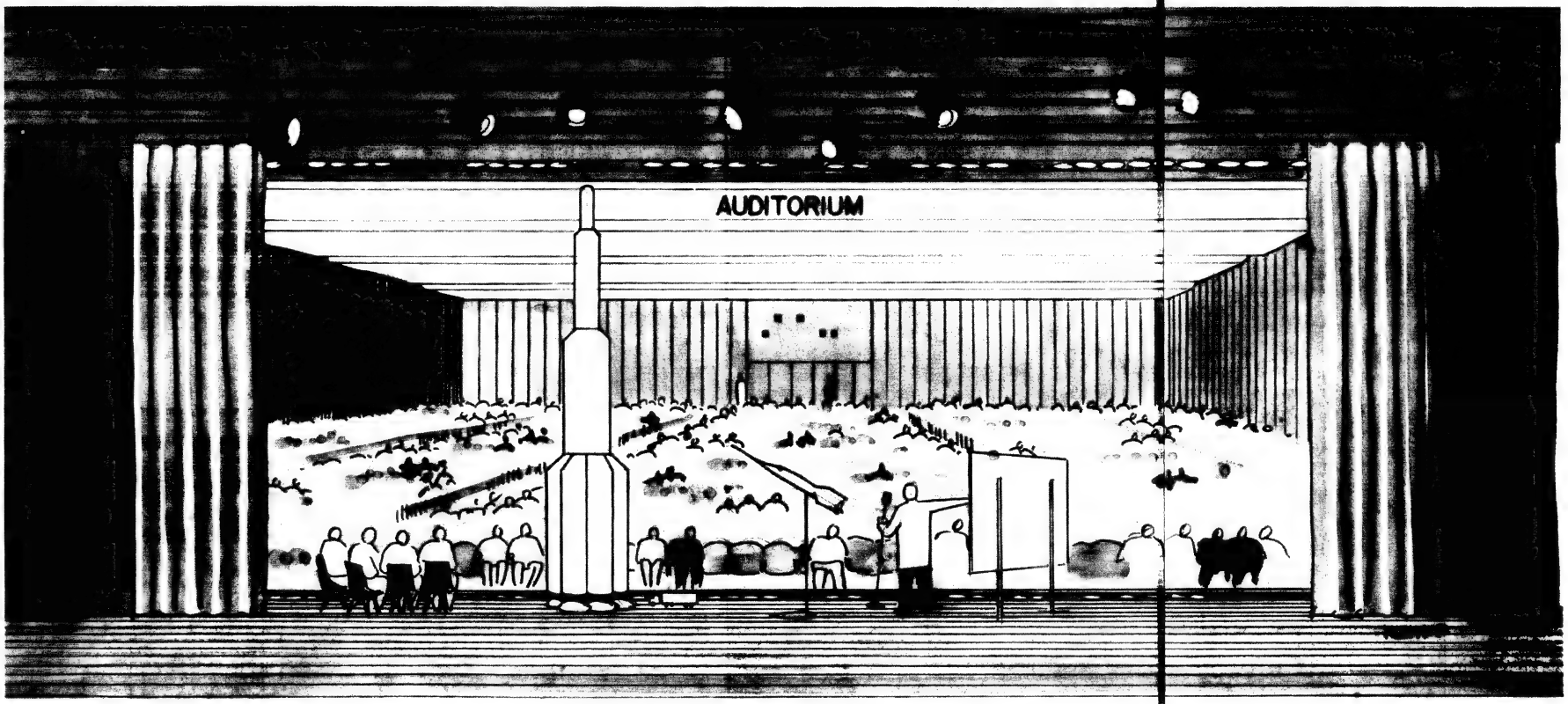

Figure 3-7. Auditorium

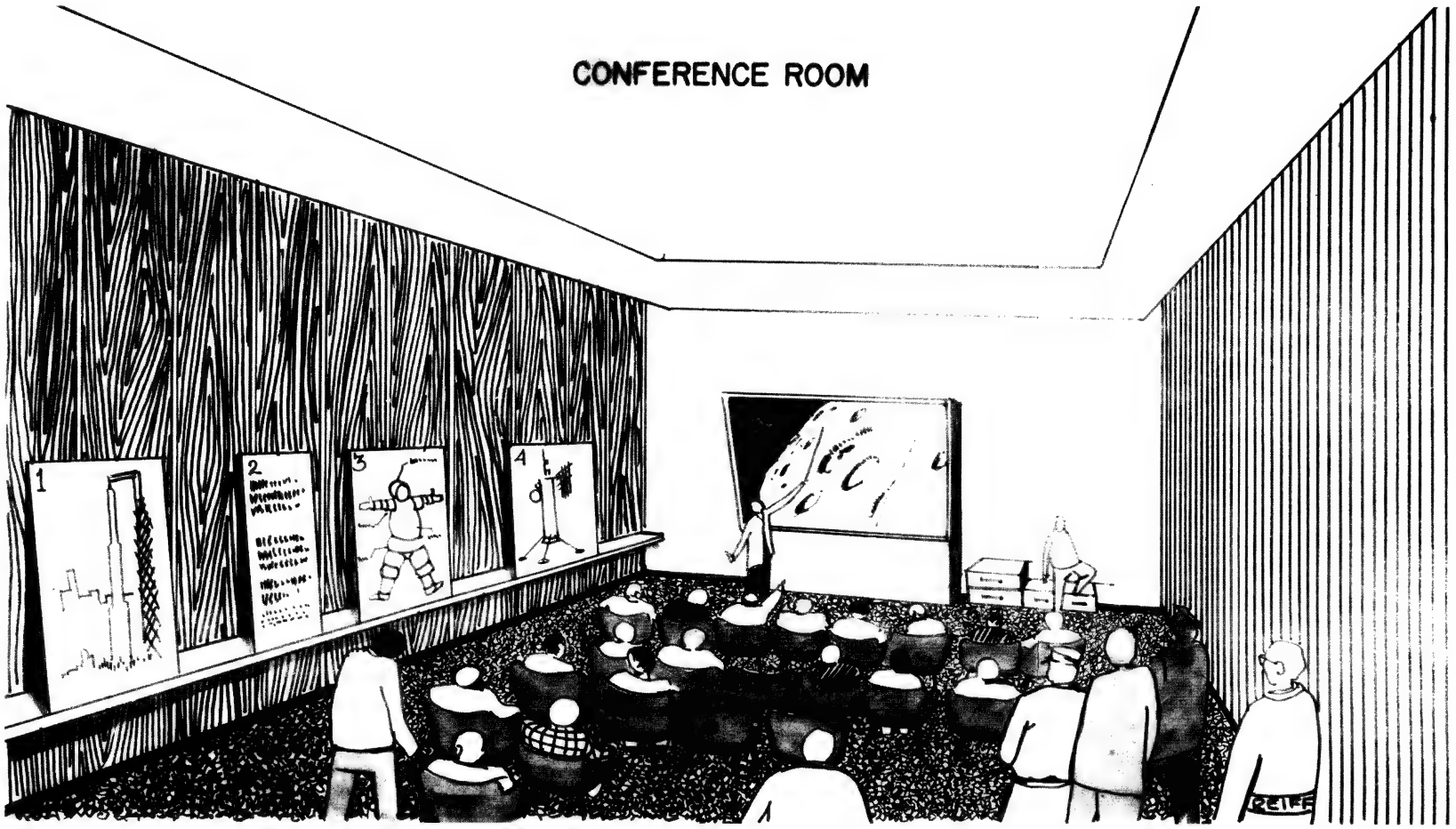

Figure 3-8. Conference Room

(a) Closed Shop - the user turns over his problem to the analysts and programmers of the Central Facility who process the problem for the user.

(b) Open Shop - the user goes to the Central Facility and, with the assistance of the Central Facility personnel, programs the solution to the problem himself.

(c) Remote Access Station - the user has an input/output station within his own building, through which he can enter data and program instructions, and from which he can obtain the results of the computation. Figure 3-9 shows the users expected to have stations for remote access to both digital and analog/hybrid computers at the control facilities.

(d) Remote Inquiry (STINFO) - to implement the STINFO program, the specialized data files of the individual organizations will, by 1975, be automated and stored in the digital computer at the Central Facility. An example is the information on machineability of materials currently held by the Materials Laboratory in a semi-automated file. All user organizations will participate in this usage and, because the required information transfer rate can be handled by a conventional Teletype system, this method of access is identified separately from remote access. Figure 3-9 shows that all users will have remote inquiry stations.

(e) Electronic Inquiry - this is a high-speed, on-line method of accessing the computer for graphic input and output. As shown in Figure 3-9, the Central Computer Facility and the VIP Conference Room of the R&T Center are expected to make use of this input/output device.

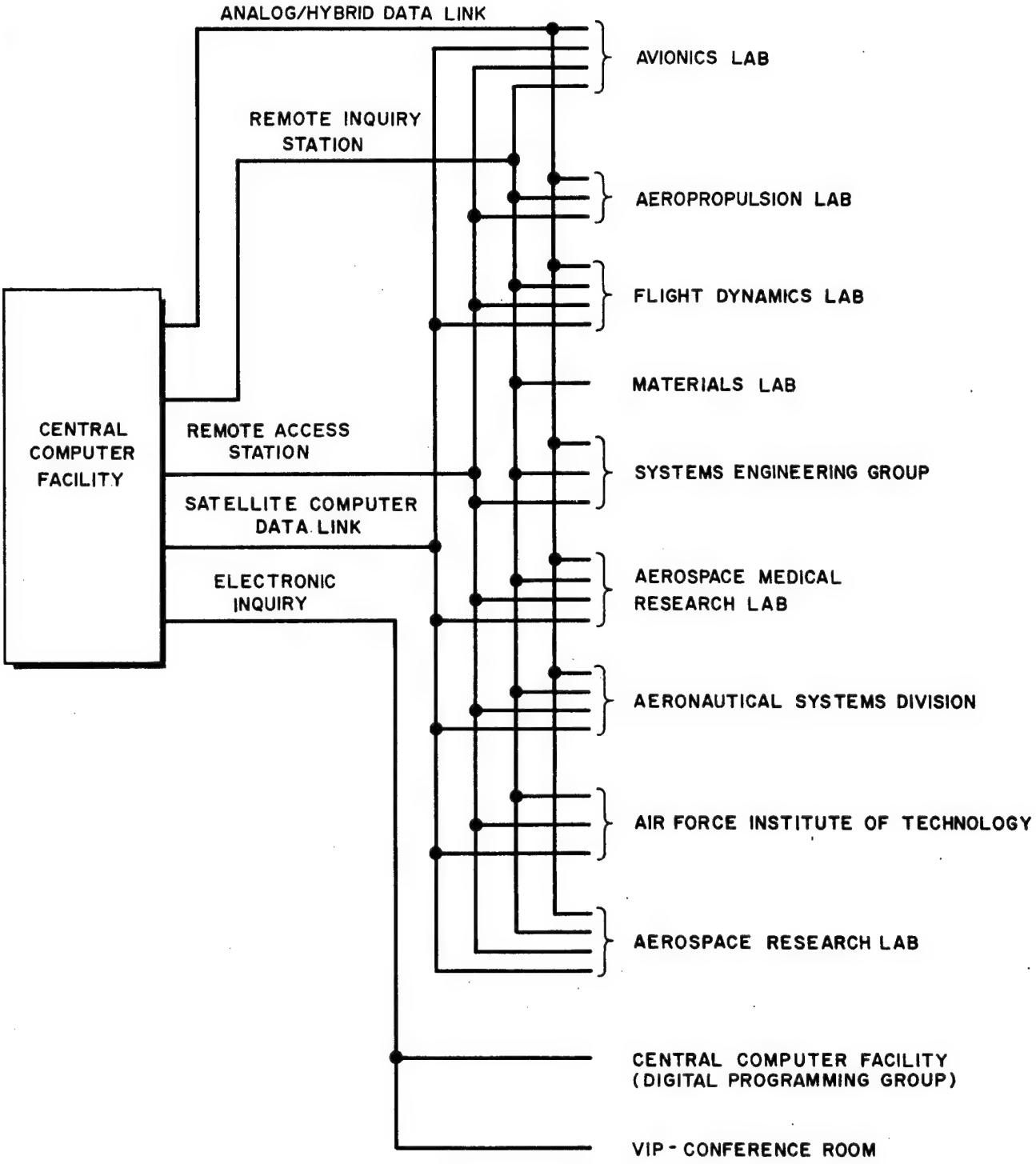

Figure 3-9. Central Computer Facility - Remote Functions

- The individual user organizations with special or on-line real time requirements will have satellite computers located within their own facilities, as shown in Table 3-5. Included will be both general-purpose and special-purpose computers, and all will be satellited to the Central Facility, i.e., will be linked via good quality telephone lines. This linking will occur at some intermediate speed memory level of the computers and will result in the satellite and Central Facility computers mutually supporting each other to absorb peak workloads.

- Off-base facilities, consisting of computers that are essentially independent of the Area "B" complex, will continue to be used. These consist of:

  (a) Contractor computers - used to construct and debug programs associated with the contractor's tasks. The present practice of performing the production runs on the Central Facility will continue; the interface point will be a compatible magnetic tape produced by the contractor.

  (b) Defense Documentation Center automated literature searches and bibliographies -- these will be carried out at the Washington office of DDC.

  (c) Other computer facilities -- either Government, industrial or university owned -- that can provide a highly specialized, one-time type of service.

Central Computer Facility Systems

The Central Computer Facility will consist of an analog/hybrid computer system and a digital computer system, as described in the following paragraphs:

- Analog Computer System - the Central Facility will initially use the present analog equipment in support of requirements on a service center basis. Eventually it will be upgraded and make use of data links for remote data gathering and experiment and simulation control. Gradually, it will become a segment of the hybrid computer system.

TABLE 3-5

INDIVIDUAL DATA PROCESSING AND COMPUTATIONAL CAPABILITY IN AREA "B"

ORGANIZATION	PRESENT	PROJECTED (1975)
Avionics Lab.	Dynamic Analyzer Complex	Will continue to require special purpose on-line/real time computers for simulation
Aero Propulsion Lab.	None	Will require specialized computer for on-line/real time use
Flight Dynamics Lab.	CDC-160A/1604 Mark II Link 434 EA/Litton Hybrid	Will continue to need specialized on-line/real time computers.
Materials Lab.	Uses Contractor NCR 304	Function transferred to central facility
Systems Engineering Group	Central Computer Facility	Continue as Central Computer Facility
Aerospace Medical Research Lab.	PDP-1 PB-440	Will continue to need specialized on-line/real time computers
Aeronautical System Division	CDC-160A/IBM 1410	Small processor for controller and special purpose computers in other group
Air Force Inst. of Technology	IBM 1620 EAI Analog	Maintain and upgrade as teaching aid
Aerospace Research Lab.	IBM 1620	Improved facility for use in research on applied mathematics and programming
DDC	None	None
Technical Library	None	None

- Hybrid Computer System - one of the more significant of advances in the computer technology in recent years is the use of both digital and analog computing elements in the same computer, appropriately labeled a hybrid. The hybrid combines the programming flexibility and dynamic range of the digital computer with the real time capability of analog computer.

- Digital Computer System - the Central Digital Computer System shown in block diagram form by Figure 3-10 will provide the following features to satisfy the requirements of the users of Area "B":

  (1) Multi-processor - the central digital computer facility will use multiple central processors to permit simultaneous processing of asynchronous multiple programs on a time sharing basis. Under the modular concept incorporated in all major computer systems, the capability of the computer can be increased by increments without requiring replacement of the equipment. Access to the processor will be by conventional input/output equipments, remote inquiry stations, remote data entry and output stations and electronic inquiry stations.

  (2) Multiple user/access - multiple user/access will be implemented by an automatic, controlled queuing system to permit users reasonable access to the processor. This queuing will be controlled by priority, type of processing (scientific computation, data manipulation, test data reduction and data base sort and search operation), user access, and processor load. Nominally, all computer programs and their major parameters will be stored at the Central Facility on magnetic tape for low-priority, minimal usage programs and in electronic form for high-priority programs for automatic entry into the data processor upon demand. The latter programs normally will be stored in a slow, large-volume mass memory system with a memory-to-memory transfer made to a fast core type memory.

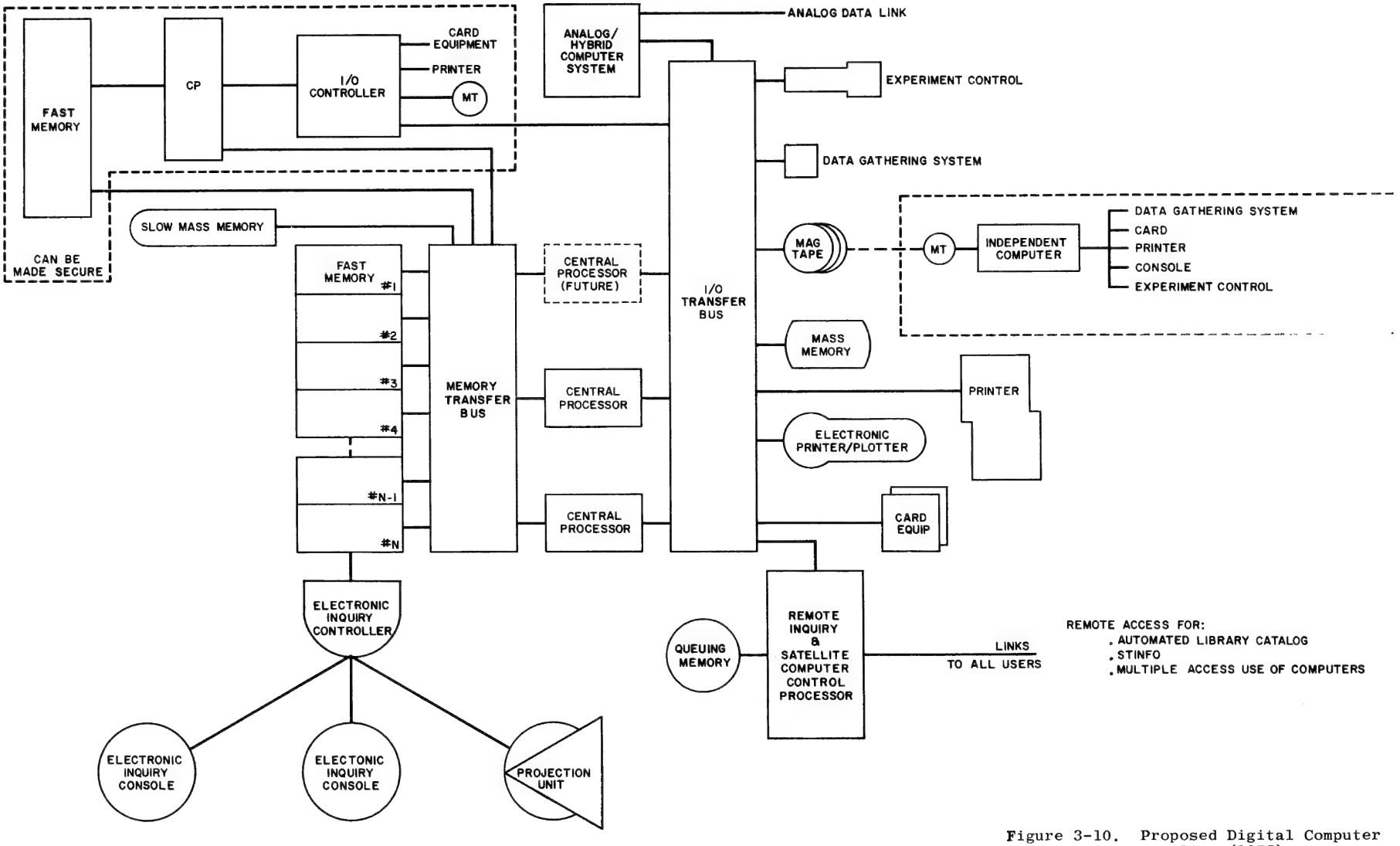

Figure 3-10. Proposed Digital Computer Facility (1975)

(3) Protected memory - in a multiple-user, multiple-access system, there is a need to protect sensitive information, such as proprietary information of either the Government or individual contractors, and management data, including personnel data. Physical and electrical safeguards will be used by requiring the user to prove his authorization to obtain the data, both at the Central Facility and at predesignated remote stations for accessing, manipulation and receipt of the data.

(4) Remote access and remote inquiry stations - to facilitate the user accessibility to the central processor from remote locations, especially for problems involving very short computer time, there will be a remote inquiry station and/or a remote data entry and output station at the laboratories and divisions at WPAFB. The remote inquiry station will provide limited data entry and outpt capability using Teletype units (10 characters per second). The remote data entry and output stations will provide low-volume data transfer capability using telephone communications links (2400 bits per second). The devices which will be used at these stations will be card read/punch system (300 cards/minute), paper tape system (400 characters per second), low-speed printer (18 lines per minute - 120 characters per line), and/or digital plotters.

(5) Electronic inquiry system - to reduce the supporting manpower requirements for operating the system, the computer programmer will be provided a system to perform his programming and program debugging operation pseudo-on-line of the computer using the electronic inquiry system for direct data base communication in alphanumeric and in graphics. This expanded data manipulation capability will enhance the overall operational control and use of the data processing system and provide the following results:

(a) Reduce turnaround time

(b) Symbolic communications

(c) Graphic communications

(d) Off-line manual operation with intercommunication with the data base at computer speed

(e) Reduce number of computer accesses and access time per problem

The use of the electronic inquiry system will permit visual programming and program de-bugging; remote computer operation control; instructional intercommunications; engineering sketches, drawings, and computation; computer aided design; PERT data management; problem solving and general data manipulation. The user will be able to edit, review, correct, add, delete, reformat, insert and manipulate the textual, tabular and graphic data. It will provide multiple hard copies and a small group dynamic computer-driven presentation for instructional, technical and management purposes.

(6) Electronic printer/plotter - the electronic printer/plotter will handle the volume production of printed and plotted data output providing high quality archival record copies at reduced cost and volume (200 to 1 reduction) at a printer speed in excess of 20,000 lines per minute and at a plotter speed requiring less than 0.2 seconds per annotated plot. The incorporation of the electronic printer/plotter will also give the Central Facility the capability of producing microfiche directly from the computer data base.

(7) Security provisions - the flexible organization of the WPAFB data processing and computation system enables the system to be adapted to handle classified work

in accordance with Federal regulations FED STD-222, NAG-2A/TSEC, and DCA-CIR-C175-6A.

(a) Each of the satellite processors will be able to handle small classified programs independently.

(b) The Analog Computer Room will be secure in itself, with manually-connected secure remote links.

(c) The Hybrid Computer Room will be secure in itself with manually-connected secure data links.

(d) The entire Digital Computer Room will be secure in itself; however, due to the multiple user/access configuration, if the entire central digital processor system is committed to handle classified work, the remote data links will need to be disconnected. To prevent dedication of the entire computer complex during prime hours, the digital computer configuration provides for a physical and electrical (signal and power) isolation of one of the central processors for commitment to classified work when required. By manually connecting the secure data link to the processor assigned to classified work, that processor can then only handle the classified work as prescribed by the remote terminal. Since the physical separation between the laboratories and divisions to the Central Facility is small, the physical transportation of the

classified data and program is recommended for maximum overall operational efficiency whenever possible.

(8) Power-loss protection - in a complex data processing and computation center, as that proposed for the Central Computer Facility, the effects of power interruption can be very serious. In a single processor facility, safeguards can be programmed in to allow relatively convenient recovery and restarting of a program after a power failure. With multiprocessors, multiprogramming, and remote access, the cost of building in programming safeguards becomes prohibitive. Therefore, space is provided in the R&T Center for emergency power sources for use in critical parts of the computers. Figure 3-11 is a view of the Central Computer Facilities as they might appear in the R&T Center. Subsection 3.6 discusses the operational concept in terms of floor plan and building layout.

3.5 COMMON SUPPORT ELEMENTS - MISSION AND OPERATIONAL CONCEPT IN BRIEF

Mission of the Common Support Elements

The common support elements, consisting of a cafeteria and additional support facilities such as barber shop, branch bank, post office, and telephone message center, have as their primary collective mission the minimization of personnel lost time due to the need to attend to personal affairs. In particular, as much as possible, need for the time-consuming trips from the base to downtown business districts is to be avoided.

At present the support facilities in Area "B" are greatly overtaxed. Lack of adequate parking, dining, and personal convenience facilities cause a significant loss of man-hours by

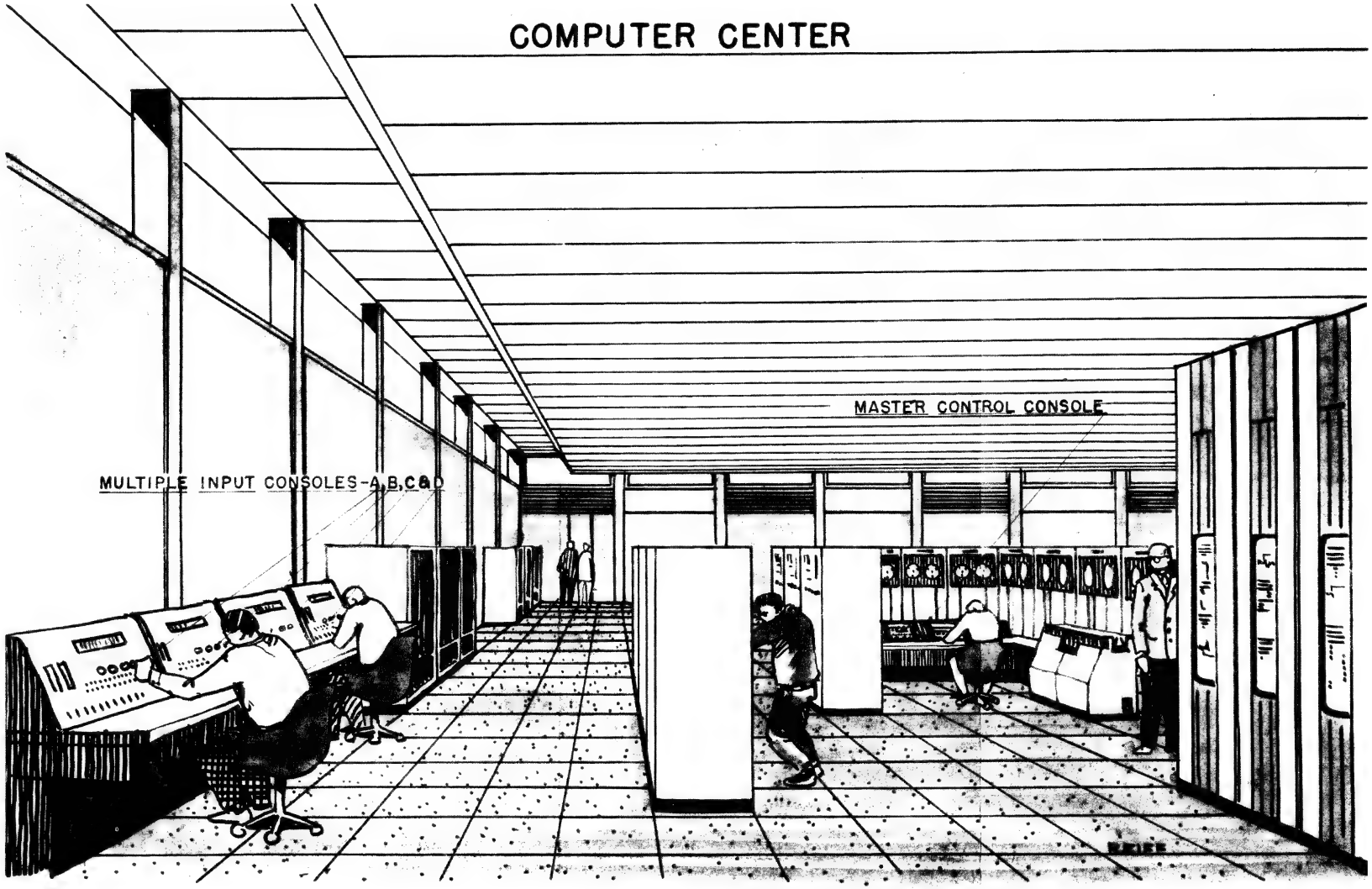

Figure 3-11. Central Computer Facilities

the users. The cafeteria for the Research and Technology Center will be designed both to accommodate the normal residents and users of the Center, and satisfy the large loads imposed by the conference facility. This requirement is the determining factor in its concept. Although the cafeteria will not meet the needs of all the other laboratories in Area "B", during days when large conferences are in progress, it can supplement the other dining facilities. It has been assumed that food service requirements will be programmed in the building services of the other laboratories, particularly since the already inadequate cafeteria of Building #126 is scheduled for removal according to the 1975 master plan.

In order to serve the needs of the conference center adequately, the cafeteria in the Research and Technology Center will provide the following:

(1) Tray service line for self-service with prepared foods.

(2) Tray service line for special order food.

(3) Coin-operated food dispensers.

The self-service tray line will process the largest number of diners and three or four sittings per seat should be realized. The special order line will closely match the self-service group, with not quite as much turnover. Coin-operated food machines will be provided for off-hour use. The VIP dining room for the Center will be on the same level as the administrative offices and will provide table service for luncheon meetings as shown in the building layout in subsection 3.6.

Significant amounts of time can be saved by Area "B" users and visitors if convenient services, which now require substantial on-base or off-base travel to reach, are provided at the Research and Technology Center. The following facilities are included in the concept:

(1) A two-chair barber shop,

(2) Bootblack stand,

(3) Newspaper and magazine/notion counter,

(4) Telephone and message center,

(5) Branch bank,

(6) Branch post office, and

(7) Small lounge area.

Not only will these serve the Research and Technology Center but they also will supplement base functions for personnel of the adjacent laboratories.

Figures 3-12 and 3-13 are views of the R&T Center cafeteria facilities. Subsection 3.6 contains a description of the operational plan of the support elements in terms of building layout.

3.6 OPERATIONAL CONCEPTS AND BUILDING CONFIGURATION

3.6.1 Technical Reference Facility Configuration

The Technical Reference Facility is shown in Figure 3-14. The Main Library facilities will be located on the main floor of the Center and the DDC facilities will be located on the lower level. To provide a degree of isolation from the conferencing and supporting elements, the main entrance to both these facilities is located on the south side of the building, adjacent to its own parking area.

The library is entered from a low-ceiling corridor, and the circulation desk is near the entrance. Directly behind the desk is the classified library, which contains approximately 1% of the total facility holdings and which is completely enclosed in a vault-like structure. In addition to the book stacks and reading tables, there will be two microfilm viewers and a small work area. The main administrative section of the library, which will have access to the central stack area at intervals, will be behind the main desk and classified vault. This section will include the library and technical reference center office and work areas. These spaces shall occupy approximately 4,000 square feet.

After passing the circulation desk the visitor enters the stack area, which is a separate space housing the collection of unclassified books, documents, and journals, with the card index located at the entrance.

The stacks are sized to handle the projected requirements, but can be increased by the addition of an upper set of stacks. The ceiling height of the initial stack area will be 7 feet, 6 inches; the ceiling will be a 3-inch slab providing the floor for another tier of stacks above. This upper stack will be accessible by small circular stairs. A small lift will be included to serve the upper level.

The floor area provided for books will occupy 9,000 square feet; the area for documents will be 6,000 square feet, and the space for journals will be approximately 1,000 square feet. The

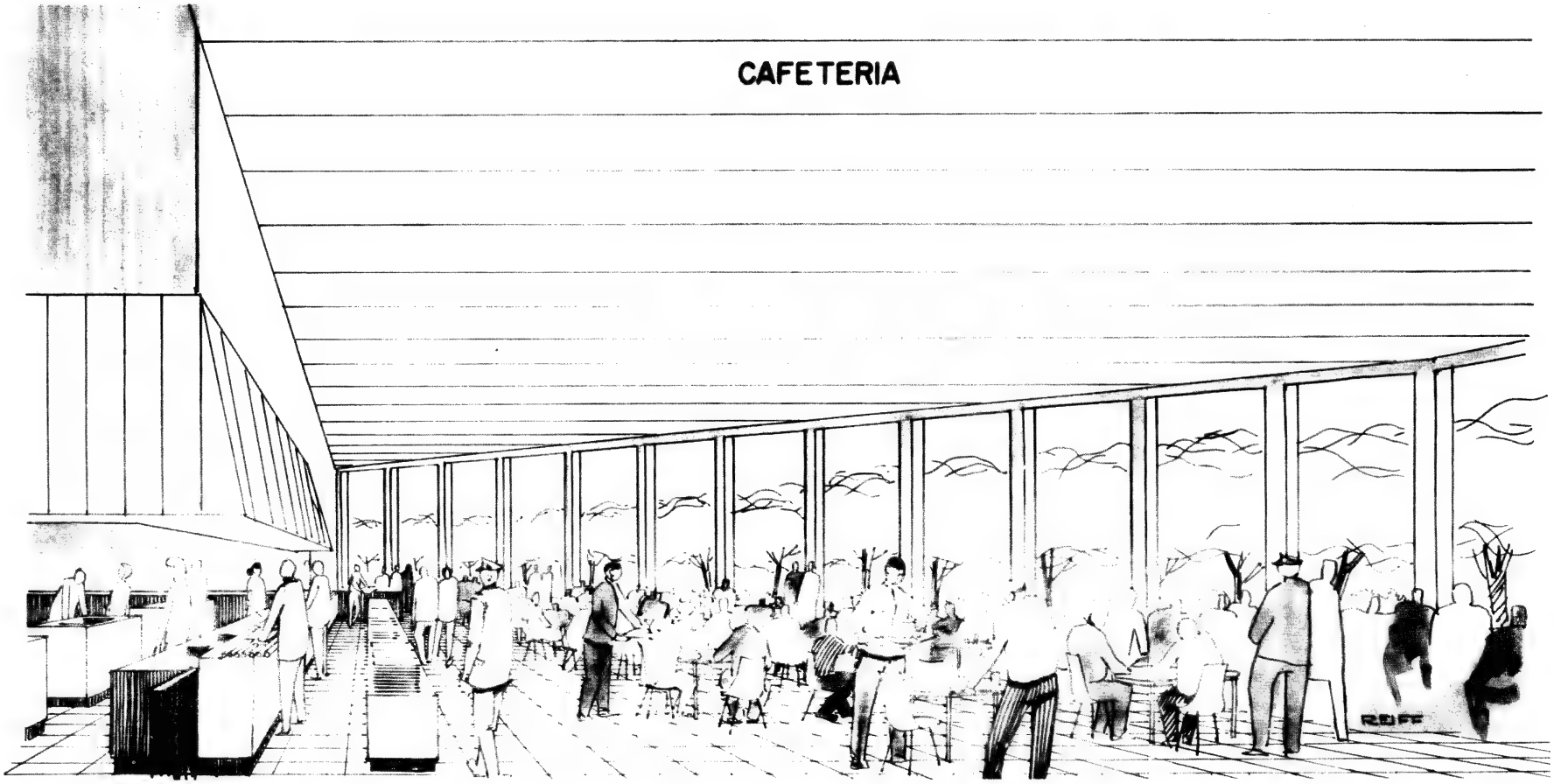

Figure 3-12. Cafeteria

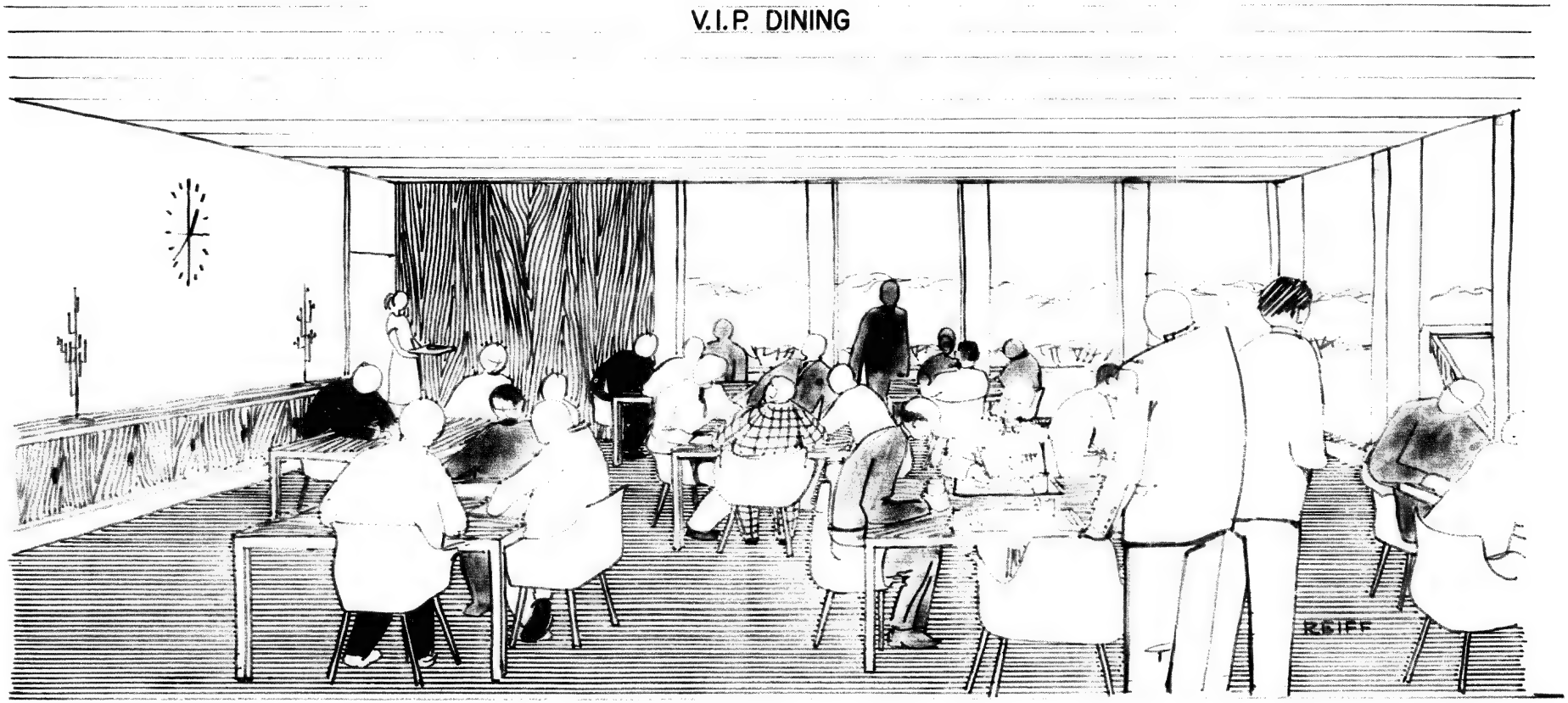

Figure 3-13. V.I.P. Dining Facilities

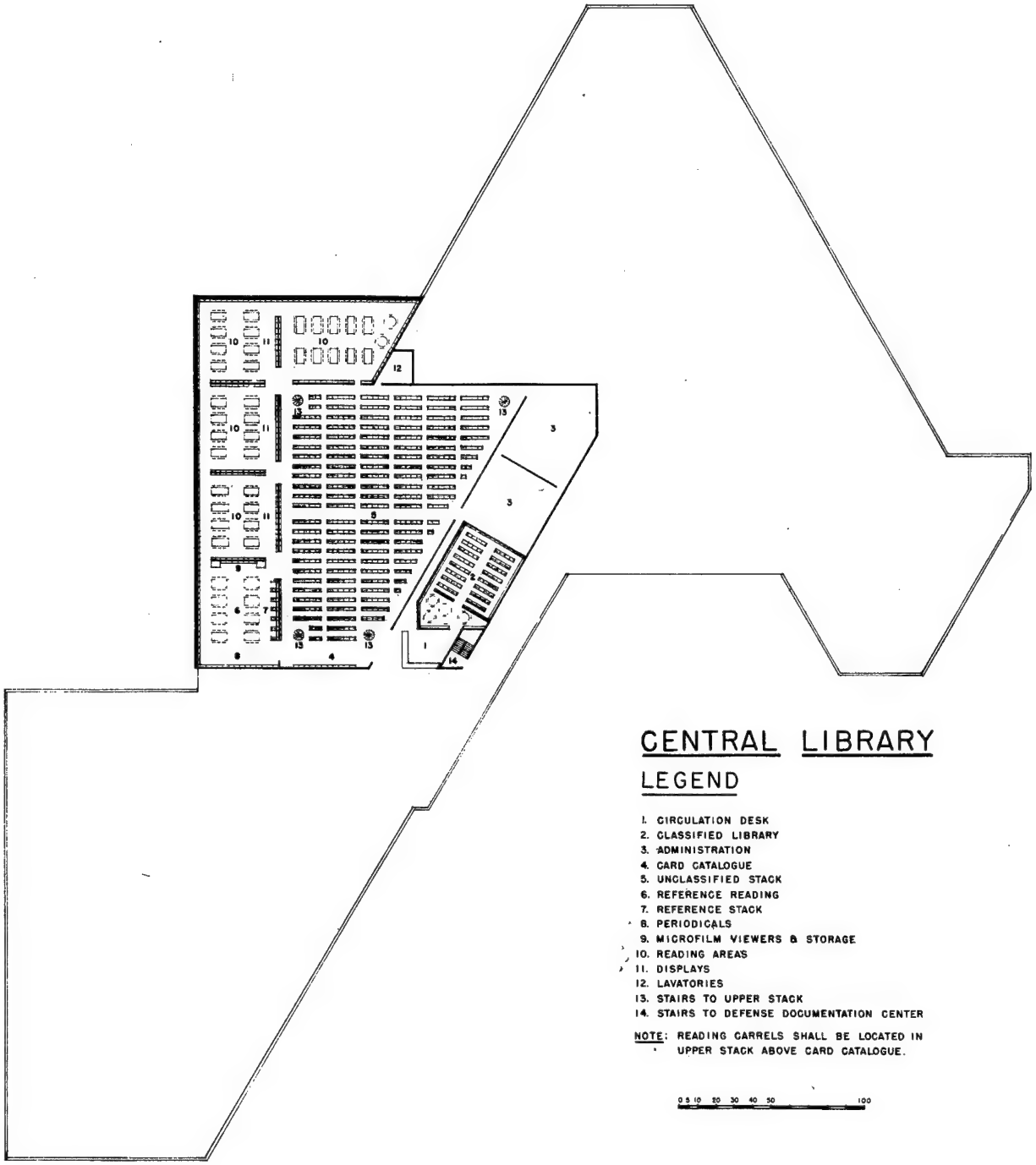

Figure 3-14. Central Library

total book storage area of the stack on one level is 13,000 square feet. If the upper tier is added, a total effective area of 26,000 square feet will be available. Surrounding the stack area will be a 6-foot-wide corridor which will open at intervals into related library spaces.

The reference area, shown earlier in Figure 3-6, adjacent to the outside periphery of the building, will occupy approximately 3,000 square feet of floor space and have a 15-foot-high ceiling. The enclosure is surrounded on two sides by open book shelves and double-loaded stack sections containing reference material. At the far end of the room will be two microfilm readers, in low partitioned area, and two tape recorder listening booths with a microfilm and tape storage file located between them.

The remaining spaces along the perimeter of the library facility will be used primarily for reading areas. This space, which has the same width and height as the reference area, will extend approximately 90 feet and will open into the corridor at 30-foot intervals. The outside perimeter wall will be used for book shelves beneath the windows and the inside wall along the corridor will be used for display of new books and periodicals. In the center of the space will be two rows of reading tables; each will provide eight reading positions. Adjacent to the center corridor will be a photocopy machine.

The entire library will be air-conditioned, and the reference and reading areas will be acoustically treated to deaden sounds.

The Defense Documentation Center shown in Figure 3-15 is reached by a stairway located adjacent to the main library entrance. This facility will occupy 5,000 square feet and will be enclosed in a vault-like structure to provide the necessary degree of security. Stacks for documents as well as a storage center for microfilm will be provided. Several large reading tables and two microfilm viewers and printers will be included.

3.6.2 Technical Conference Facility Configuration

The Conference Facility is located directly in line with the main building entrance and is shown in Figure 3-16. The largest and most prominent space will be a 1,200-seat auditorium. Besides the seating capacity, this space will provide a proscenium which will include a stage and projection screen. The other elements are four conference rooms, each capable of seating 200 persons. These will be located back of the auditorium adjoining the foyer. These spaces will be capable of subdivision and one of the rooms will have permanent equipment for rear projection. Portable projection equipment will be

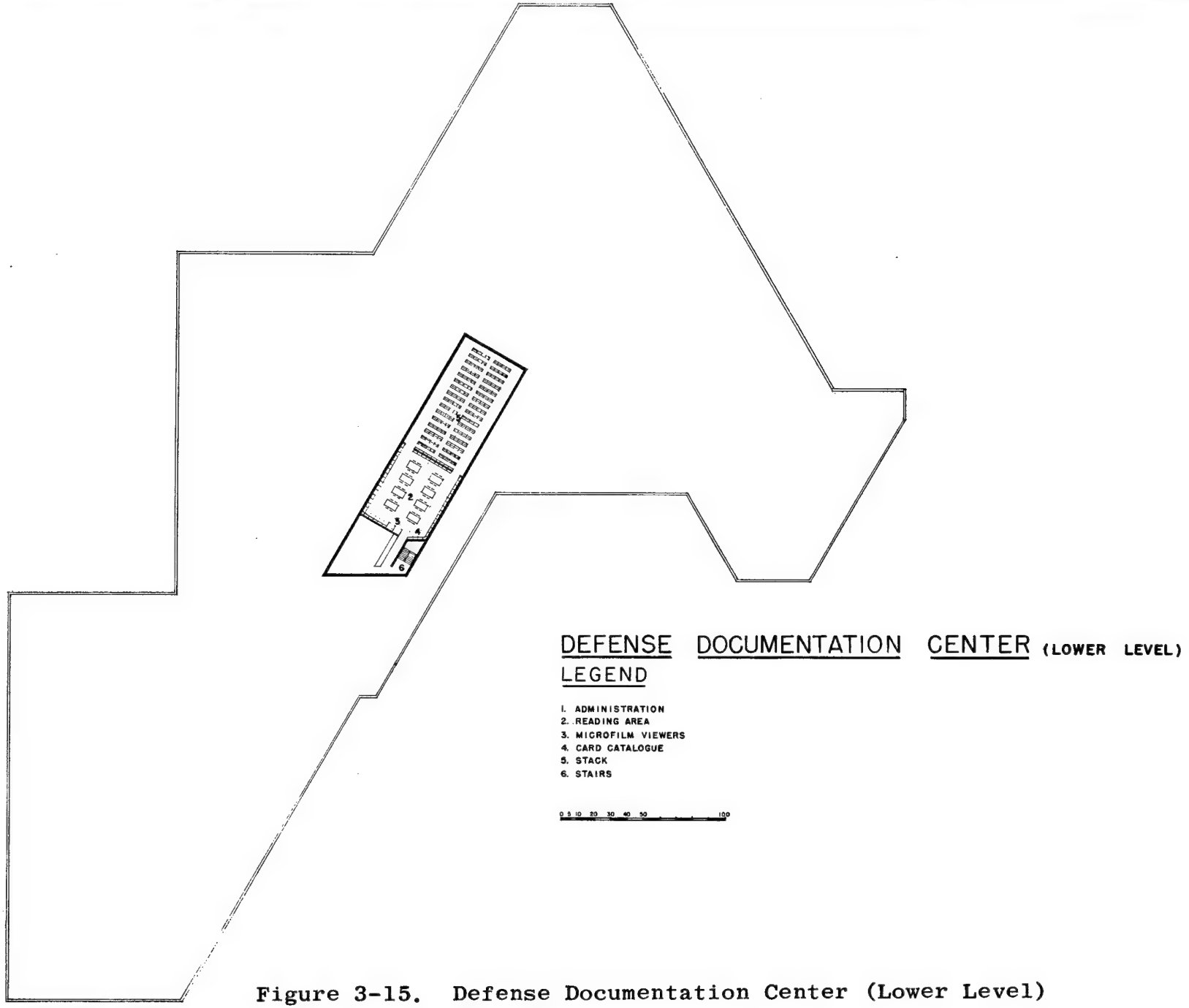

Figure 3-15. Defense Documentation Center (Lower Level)

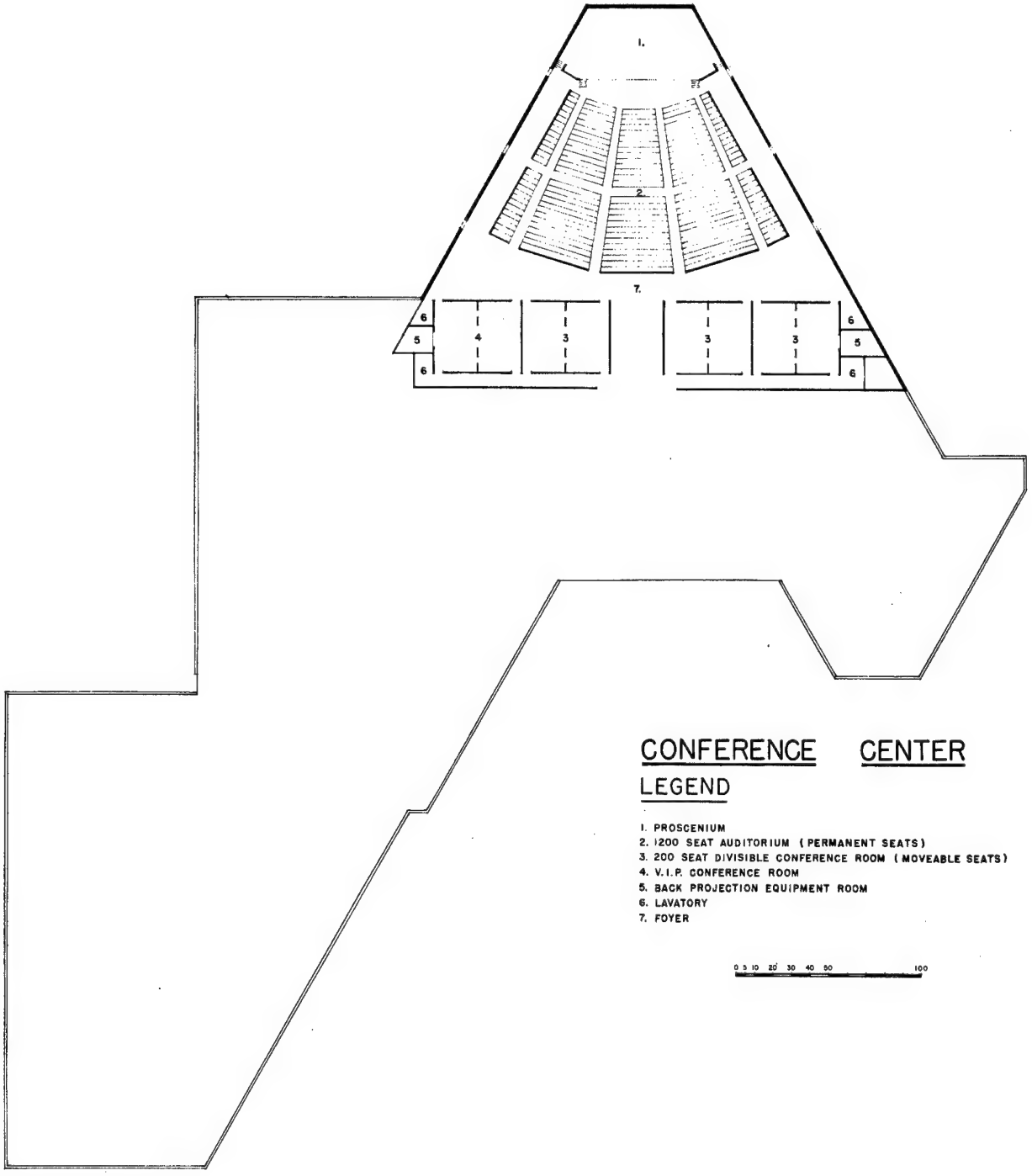

Figure 3-16. Conference Facility

available for use in the other spaces. All parts of the Conference Center will provide maximum security. It will be possible to hold both classified and unclassified meetings simultaneously by the use of separate rooms. All entrances to both the auditorium and the conference spaces will have double doors, which form an acoustical baffle for security purposes.

Entrance to the center from the building lobby is via a 30-foot-wide passage, adequate for the flow of large groups of people. Shortly beyond this point will be 6-foot-wide corridors at right angles on each side which will serve the four conference spaces. The design is such that, under most normal circumstances, a single guard can provide a security check point.

From the auditorium foyer the floor will pitch down to the proscenium. The permanent seating is arranged in a conventional manner. The ceiling of the conference room will slope up to the proscenium. Adequate emergency exits will be available on both sides of the auditorium, through a secondary foyer, which will open to the outside, and this secondary foyer should provide the necessary security control.

All rooms within the Conference Center will have artificial lighting only, and will have separate air-conditioning systems. Rest rooms at both the north and south ends of the main foyer will also be accessible from the conference corridors.

The total area of the Conference Center is approximately 34,600 square feet. This allows 12,000 square feet for the main auditorium, 8,000 square feet for the conference rooms, 2,600 square feet for the proscenium, and the remaining area for circulation, security and services.

3.6.3 The Computer Facility Configuration

The Computer Center layout is shown in Figure 3-17 and features a central machine area of approximately 12,500 square feet in which all the computers are located. The central computer space will be divided initially into two areas -- analog and digital. These areas will require approximately 4,000 and 8,500 square feet respectively. Below this area will be a subfloor vault in which the interconnecting cables and wires will be laid. This vault will allow adequate separation of power signal lines and provide flexible interconnection for all types of equipment within the DOD Red/Black Criteria. The computer area will be subdivided according to departmental requirements, but the walls can be relocated as required in the future. Although movable, the walls will meet security requirements.

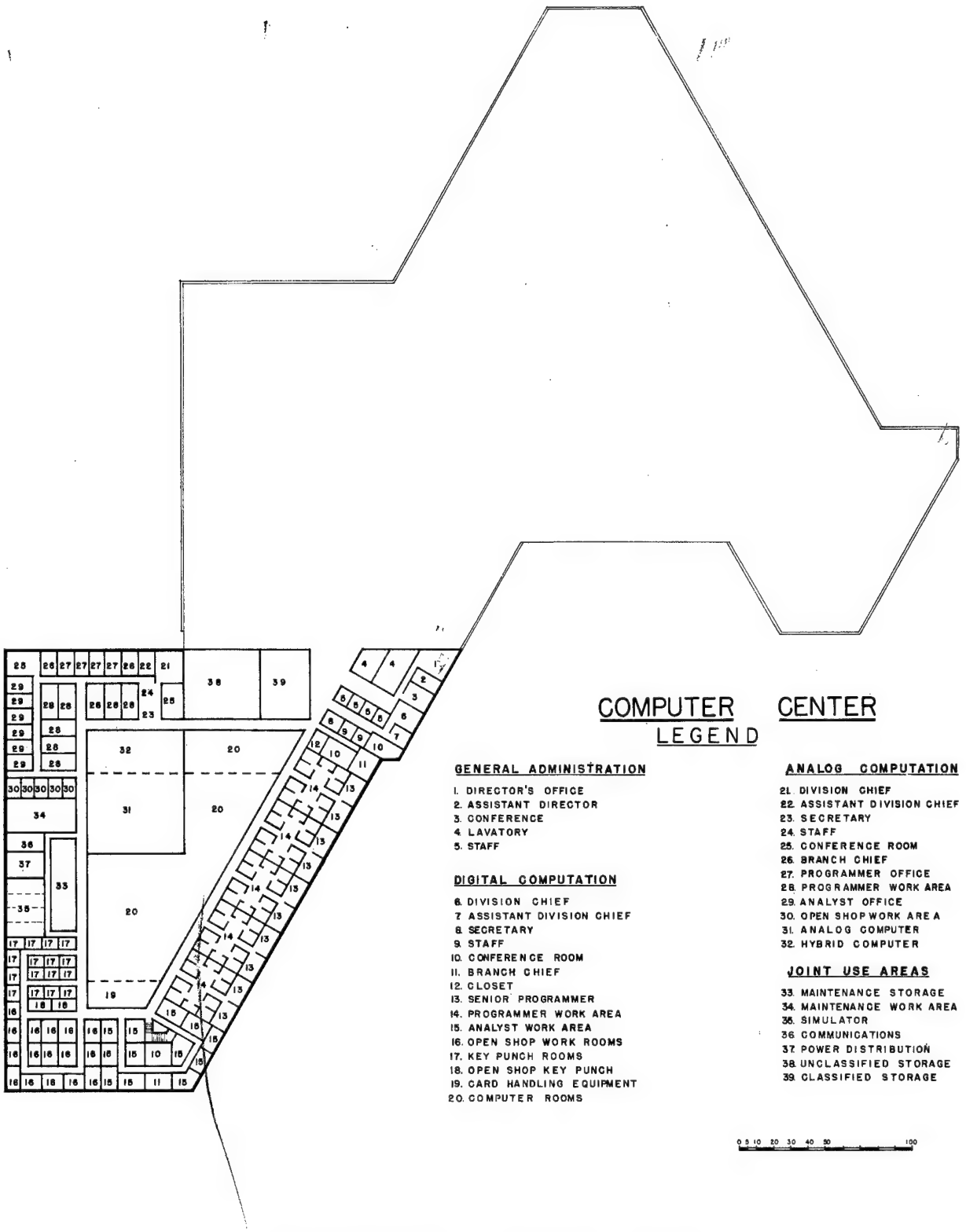

Figure 3-17. Computer Center

The computer machine area will be surrounded by a corridor, with administrative, programming, analyst, and maintenance spaces located on the outside wall. These spaces will include work areas for visiting scientists and engineers as well as spaces for the professional staff of the facility. By segregating the machines from other related activities, provisions can be made for meeting the special environmental requirements of the computers, such as temperature, humidity, dust, fire prevention, and sound control. Also, having all the machines located in the same area will allow them to be organized in any configuration which may be necessary. The main corridor will allow effective visitor control without interruption to the users, and security measures can be provided for all sections of the facility which will be processing classified data. The relationship between all areas of the computer facility is designed to provide the most efficient workflow through input, processing, output, and scheduling areas.

A standby power source will be provided to protect those parts of the computers which would suffer significantly in the event of a power failure.

The entrance to the computer complex is located adjacent to the library entrance on the south side of the building. The Computer Center is located in a wing of the Research and Technology Center, remote from the Conference Center and cafeteria, primarily to minimize outside disturbances. It is connected to the main lobby by a corridor and most of its users will use the south entrance which has a separate parking lot.

The digital computer division of the Center is located to the left of the entrance corridor. Along the outside of the corridor, there is an administration area which will occupy 1,300 square feet. This space will be subdivided into permanent offices, with natural light, for the division chief, and a conference room. The other spaces adjacent to these will be two additional conference rooms for general use; one of these will serve as a classroom for computer programming and orientation courses.

Across the corridor from the administration area will be one of the two digital computer rooms, illustrated earlier in Figure 3-17. Although the entire facility is secure, this room can be separated from the other computer spaces by full height, secure partitions so that classified problems can be handled while the remaining portions of the computer are working on unclassified problems. A large amount of power will be consumed in the computer machine room, resulting in a high heat dissipation, and so special air-conditioning will be provided. The area will require special acoustical treatment to reduce noise levels. A non-liquid type fire extinguishing system will be mandatory.

Next to the digital administration area will be located branch chiefs and space for senior programmers, each space having an associated programmer work area connected to it. This programmer work area will be divided into individual booths by low partitions. Adjacent to the other office will be offices for analysts. The second digital computer room will be across the corridor from the programmer and analyst areas. It will have the same general characteristics of the other computer room. Subdivision of this room may be used to help control sounds. The air-conditioning will not only serve the computer rooms, in general, but can also serve those machines, such as large memory units, that require such an environment. There will be an enclosure for the chief operator and two smaller offices for the machine operators. The chief operator's office will have glass partitions and have a full view of the entire computer room. The machine room will also contain the card processing equipment.

Adjacent to the programmer and analyst spaces, there will be open shop workrooms for transient users and two open shop key punch rooms. Next to these will be a separate room for closed shop key punching. These spaces will have medium power requirements, and require special heat dissipation consideration. A non-liquid fire extinguishing system will be available. The area will have high partitions and will be acoustically treated. There will be a space for files and supplies.

A number of work areas are shared between the Digital and Analog Divisions. These include maintenance area, storage areas, communications terminal area for use with remote accessing, power distribution rooms, and space to hold up to four special-purpose simulators. The simulator area will have movable partitions to accommodate the various sizes of simulator, and provide privacy for the users. These spaces are located next to the closed shop key punching room. These spaces will be provided with non-liquid fire extinguishing systems. A wiring vault will be provided beneath the floor of the maintenance area and the communications terminal equipment area.

On the right of the entrance, but remote from the building exterior, will be enclosures for the storage of unclassified material for the entire computer facility. Storage space will be provided for magnetic tape, which shall be remote from power lines, for cards and paper supplies. The administrative offices of the Analog Division will be just beyond the storage area on the outside of the main corridor, positioned so as to receive natural light. This area will include the division chief's office, the assistant division chief's area, which shall be a high partitioned enclosure, and a conference room, which can also be used as a classroom. The interior portion of this space, which will be divided by high partitions, will be used for the

division chief's staff. The remaining area will be used for a second conference room that serves the entire Analog Division.

Adjacent to the administration area will be offices for the branch chiefs, and for senior programmers. A partitioned work area is provided for additional programmers. Also adjacent to the chief's office will be offices for analysts and open shop work areas. A supply storage area of 50 square feet will be provided. All of these areas will be separate rooms with individual security doors.

3.6.4 Supporting Facilities Configuration

Figure 3-18 shows the common support elements proposed for inclusion in the R&T Center. The cafeteria facility will be located to the right of and adjacent to the main lobby and will be shaped like a truncated pyramid, and appears in general as previously shown in Figure 3-12. The space will cover approximately 12,000 square feet and will extend 20 feet high from the floor to the ceiling. The exterior walls will be mostly glass, providing an attractive exterior view. On the left, near the entrance, there will be a food service counter. Also adjacent to the entrance and on the right hand side will be a cashier's station. The kitchen will be located behind the food service counter and will require approximately 5,000 square feet. The kitchen will have an independent service entrance.

Adjacent to the cafeteria entrance and the main lobby will be the remaining supporting facilities. As described in Section 3.5, they will include a two-chair barber shop, bootblack stand, newsstand, message center, branch bank, branch post office, and lounge. These will occupy a total area of approximately 2,000 square feet.

Directly above the kitchen and supporting facilities will be a VIP dining space with table seating as shown in Figure 3-13. This dining space will have a 12-foot ceiling and possess a particularly attractive view of the building entrance and the Area "C" facilities in the distance. It will be accessible from the lobby by both a stair and a small lift and will occupy a total area of 3,000 square feet. The administrative offices of the R&T Center are located adjacent to the VIP dining room as shown in Figure 3-19.

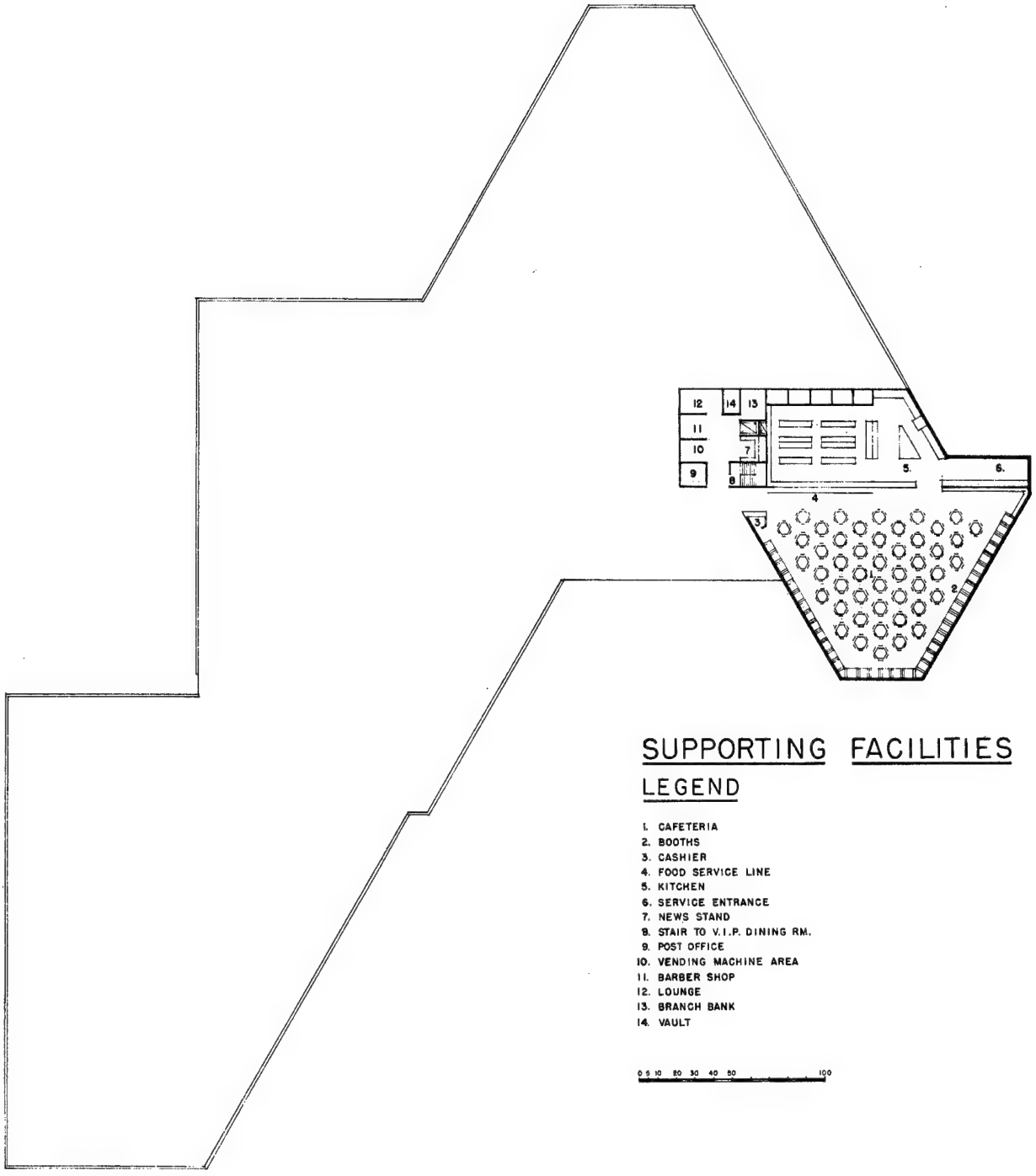

Figure 3-18. Supporting Facilities

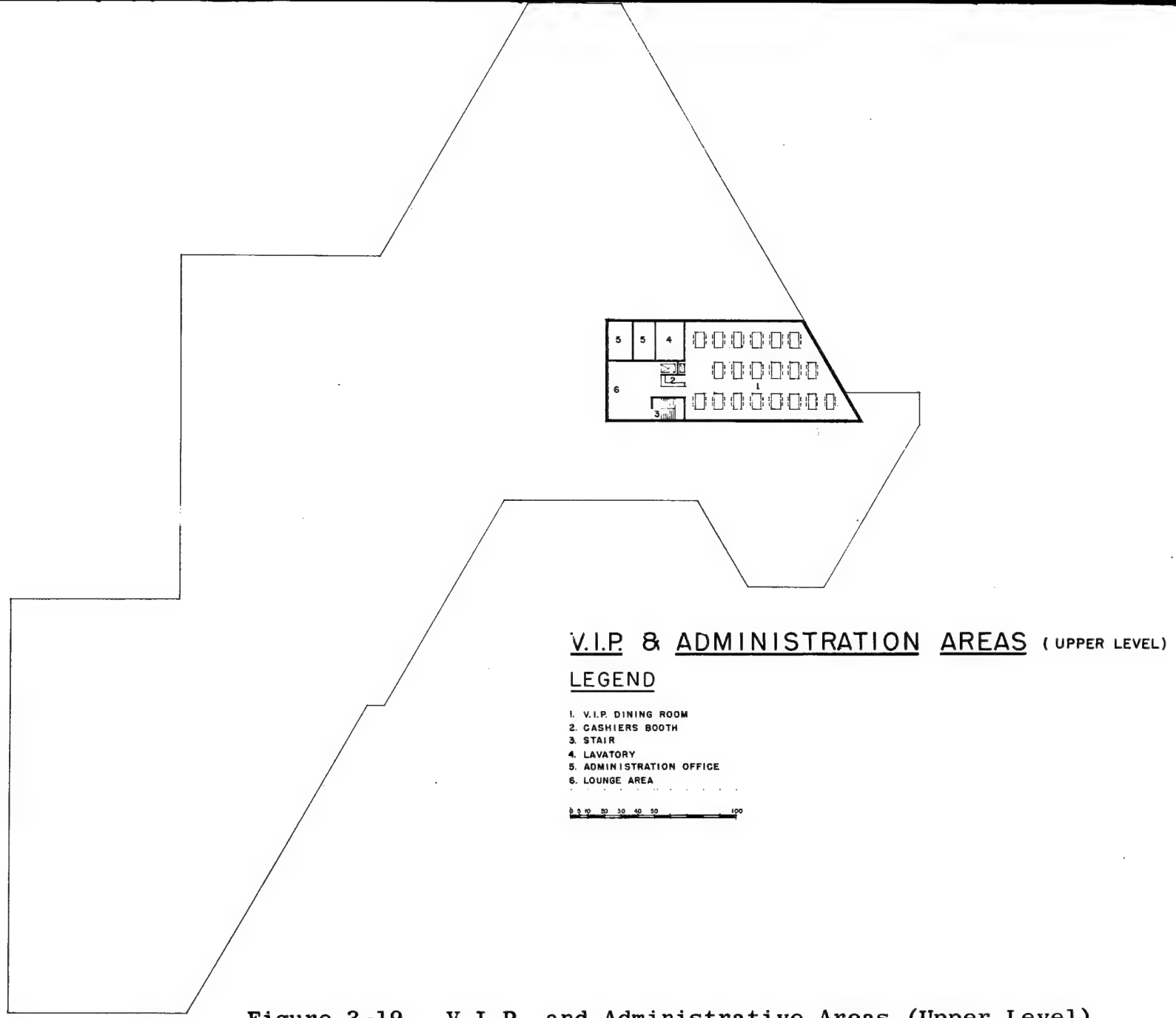

Figure 3-19. V.I.P. and Administrative Areas (Upper Level)

SECTION IV

JUSTIFICATION FOR THE ESTABLISHMENT OF THE R&T CENTER

4.1 SUMMARY

The conclusion derived from the analysis to be presented is that it is entirely reasonable to expect the R&T Center, in its first 10 years of operation, to result in savings to the Air Force conservatively estimated as being between 4 and 20 millions of dollars. It is difficult to see that the savings would be less than the minimum of four million; it is quite possible that the savings in this period would be as high as 30 million dollars. Note that this total saving is only for the first 10 years of operation and that a building of this type can be expected to have a useful life of 30 to 50 years.

There are three broad basic approaches, all of which provide justification for the establishment of the R&T Center. These approaches are enumerated as follows:

- Increased Personnel Efficiency Resulting from Establishment of R&T Center.
- Comparison of Cost of R&T Center to Other Construction or Maintenance Costs Eliminated by R&T Center Construction.
- Cost-Effectiveness Impact of R&T Center on Future Air Force Programs.

The three approaches above are separate and distinct and, therefore, the total savings from the three approaches sum to make the total justification for the R&T Center. Table 4-1 summarizes the results obtained in the analyses presented in the following pages.

Table 4-1 should be read with the following in mind. First, the minimum saving due to increased efficiency was calculated on an extremely conservative basis and calculated for only a five-year period. The more realistic figure was determined by calculating the savings over a 10-year period and using estimations which seemed more realistic than those used for the conservative estimate. The savings due to construction costs avoided are, in the conservative estimate, due primarily to the inevitable costs required to make the present computer building conform to recent DOD security requirements. The more realistic requirements make the additional assumption that if the R&T Center were not to be

developed at least one user would require a general purpose digital computer, the purchase of which would not be necessary under the R&T Center concept. Finally, the savings due to impact on future programs represent extremely conservative estimates in an area where it is difficult to make quantitative determinations. These latter figures might quite reasonably be multiplied by factors of 10 and still be logically explained in terms of the large sums spent in the Air Force programs influenced by the work in Area "B".

TABLE 4-1

SUMMARY OF ESTIMATED COST SAVINGS
REALIZABLE THROUGH R&T CENTER

Approach to Justification	ESTIMATED SAVINGS	
	Minimum	Realistic
Increased Efficiency	$2,000,000	$8,000,000
Construction & Maintenance Costs Avoided	1,000,000	6,000,000
Impact on Programs	1,000,000	5,000,000
TOTAL SAVINGS REALIZED THROUGH R&T CENTER	$4,000,000	$19,000,000

4.2 SAVINGS RESULTING FROM INCREASED EFFICIENCY

The master plan for Area "B" shows that the center of technical activity will, in the time frame under consideration, shift from its present location to somewhere on the hill above Area "B". Since the R&T Center must service all Area "B" technical employees, the site of the R&T Center has been selected to be as close as possible to the users. This, coupled with the availability of sufficient land to construct the Center and provide adequate parking, all adds to making the choice of a site in the hill area a logical one.

Note from the Area "B" Master Plan, Figure 2-1, that the R&T Center is surrounded by user facilities, specifically by the Aerospace Research Laboratory, the Aerospace Medical Research Laboratory, Flight Dynamics Laboratory, and the Materials Laboratory. Further, it is convenient to all Area "B"

users and has provisions for adequate parking for users from Systems Engineering Group, for example, who may prefer to drive up the hill in inclement weather. At present, the library receives approximately 30,000 visits a year by Area "B" users. Including both the library and DDC, it appears conservative to estimate 40,000 visits per year to the Central Technical Reference Facility. Following this reasoning through, a resulting cost-effectiveness for the CTRF of $400,000 over a five-year period is derived as presented in Table 4-2. This figure is highly conservative for reasons presented in the following paragraphs.

The average salary of a library user has been taken as $10,000 per year with a 100% overhead. The $10,000 salary is near the bottom of the GS-11 category in civil service and library users, being primarily technical, will be at this grade or higher. Hence, the actual average salary is probably several thousands of dollars higher than that taken here.

The cost saving has been carried over only five years, although the facility will obviously have a much longer effective life. An efficiency improvement factor of only 20% has been taken. Efficiency factor is defined here to mean the percentage of the total time formerly taken for a task which is eliminated due to the establishment of the R&T Center. Parking is a serious problem with the present Area "B" Main Technical Library and, hence, many users walk rather than drive to the library. The time savings involved in decreased travel time can be expected to be on the order of 15-20 minutes, which alone is approximately a 20% improvement factor. Further, the collocation of DDC and the Main Technical Library means that all sources can be searched in one trip rather than two. In addition, the automated catalog guides the user to the specific references of interest even before his visit. Thus 20% increase in efficiency is an extremely conservative overall estimate.

Spreading the savings over 10 years, increasing the average salary to $11,000/year, and the efficiency factor to 30% would raise the savings involved to a figure of approximately $1,300,000.

A similar analysis has been carried out for the conferencing facility and is presented in Table 4-3. Here too, an extremely conservative approach has been taken. It has been assumed that there will be no growth in the number of conferences held at WPAFB Area "B". Large conferences have not been considered at all on the basis that many attendees to large conferences are visitors to the base. Thus, the total number of conferences per year given in Table 4-3 is extremely conservative. Further, the same conservative salary costs are used and, in this case, an efficiency factor of only 10% is applied. It is presumed that people come to conferences

in groups so that the parking problem is less serious than it would be if each individual came separately. Further, conferences will not be decreased in length or changed in format because of more suitable facilities. Thus, the savings in time can be attributed only to the convenient location and more readily available parking space. Recall, however, the very serious problems in Area "B" associated with large secure conferences and that these problems have not been factored into Table 4-3.

TABLE 4-2

COST SAVINGS IN LIBRARY FACILITY

Number of visits per year	40,000
Average duration of visit (within library)	1 hour
Man hours/year involved	40,000
Man years involved	20
Salary cost @ average $20,000/man year	$400,000
Salary cost over five years	$2,000,000
Savings involved at 20% efficiency	$400,000*
*Minimum Savings - see text	

TABLE 4-3

COST SAVINGS IN CONFERENCE FACILITY

Number of conference man-days/year	32,000
Number of conference man-years/year	128
Salary cost @ average $20,000/man years	$2,560,000
Salary cost over five years	$12,800,000
Savings involved at 10% efficiency	$1,280,000*
* Minimum savings - see text	

If the savings calculated above were spread over 10 years at an average salary of $11,000 per year, and the number of man days in conference increased to 50,000 per year, the cost savings would be raised to a figure of $4,400,000.

Estimating the cost-effectiveness of the Central Computing Facility on the basis of time saved is somewhat more difficult than were the two previous cases. Table 4-4 shows the calculation for the analog facility. The number of problems per year represents present activity level and presumes no growth. The number of visitors and length of problems are both believed to be conservative. A 10% efficiency factor was taken since the real cost-effectiveness case for the analog facility is not so much based upon time saved for the user, but upon the impact that use of the facility has upon the Air Force programs. The 10% figure is based mainly upon savings in travel time and in ease of access of the facility.

TABLE 4-4

COST SAVINGS IN ANALOG/HYBRID FACILITY

Number of problems per year	80
Average number of visitors per problem	2
Weeks per problem	2
Total man weeks	320
Total man years (approx.)	6
Salary cost/year	$120,000
Salary cost over five years	$600,000
Savings involved @ 10% efficiency factor	$ 60,000

The figure of $60,000 cost savings if extended over 10 years at an average salary of $11,000 per year for 100 problems per year would lead to a figure of $165,000 savings.

The cost savings in the digital facility on the same basis are presented in Table 4-5. These figures, too, are conservative. The 7,000 problems per year figure is derived from computer workload statistics for 1965. Hence, no increase in computer usage is presumed -- a very conservative presumption. The 20% efficiency factor should be considered to be extremely low, since the multiple user access and remote link complex should lead to efficiency factors on the order of 50%. Using a 10-year period at a $11,000/year salary figure, 10,000 problems per year, and 50% efficiency factor, the savings could be $2,200,000.

TABLE 4-5

COST SAVINGS IN DIGITAL FACILITY

Number of problems per year	7,000
Average number of visitors per problem	2
Hours per problem	2
Total man hours	28,000
Total man years	14
Salary cost/year	$280,000
Salary cost over five years	$1,400,000
Savings involved at 20% efficiency factor	$280,000

The savings resulting from increased efficiency of personnel are summarized in Table 4-6.

TABLE 4-6

SUMMARY OF SAVINGS - INCREASED EFFICIENCY OF PERSONNEL

Item	Conservative Savings (Extended over 5 years)	Realistic Savings (Extended over 10 years)
Reference Facility	$ 400,000	$1,300,000
Conferencing Facility	1,280,000	4,400,000
Analog Facility	60,000	165,000
Digital Facility	280,000	2,200,000
TOTAL	$2,020,000	$8,065,000

The conclusion then is that, over a 5- to 10-year period, the R&T Center will be worth somewhere between 2 million and 8 million dollars purely on the basis of increased efficiency of personnel. These figures are believed to be extremely conservative.

4.3 JUSTIFICATION BASED ON CONSTRUCTION AND MAINTENANCE COSTS AVOIDED

While the present Main Technical Library is inadequately housed in awkward quarters, the facility taken as a structure is soundly constructed, and it is not anticipated that extensive repairs or alterations would be required in the next few years.

Area "B" does require more adequate conferencing facilities, however, and if the R&T Center were not to come into existence, some facilities would have to be provided for secure conferences with a seating capacity of 1,000 or more. Such a facility would be required to have a minimum of 10,000 square feet, and cost a minimum of $200,000. This figure is quite conservative since, in addition, other facilities in the planning stage would undoubedly incorporate larger conference rooms if they were not able to rely upon the R&T Center facilities.

The Computer Center is presently housed in Building 57 -- a former warehouse that has already been in use five years longer than its predicted economical life. Under the terms of DOD Directive 55200.10, dated October 14, 1964, the present computer operation must conform to rigid security requirements. This will require a complete rehabilitation of those portions of the building containing commercial computing and communications equipment. In addition, several other changes must be effected before the present facility can meet minimum operational requirements in the 1970-75 time frame. These are listed in Table 4-7, along with the estimated cost and reason for each item. In all cases, a conservative estimate of costs was made, based on current practices and costs. The result, as shown in Table 4-7, leads to a cost saving of $928,000.

Finally, there is a small but significant cost saving of about $50,000 involved in the construction of a single center providing library, conferencing, and computing facilities under a single roof. This simply reflects obvious savings in having a common lobby, common operating personnel, and common service facilities. Table 4-8 summarizes the cost savings just presented.

While not a construction or maintenance cost, there is the consideration of the reduction in individual computer purchase requirements which is brought about by the creation of the R&T Center. One large-scale, general-purpose digital computer alone would cost on the order of five million dollars. It is evident that such a requirement will develop in a number of laboratories unless the multi-user remote access concept of the Central Computing Facility is put into effect. The Avionics Laboratory, the Aerospace Medical Research Laboratory, and Flight Dynamics can be expected, for example, to develop such requirements. Thus, it is reasonable and conservative to estimate five million

TABLE 4-7

MINIMUM ALTERATIONS TO EXISTING COMPUTER FACILITY REQUIRED TO COMPLY WITH DOD 55200.10

Alteration	Est. ($1000)	Reason
Shielding to meet security requirements	600	All commercial equipment used for classified work must have electromagnetic and acoustical shielding of walls and ceiling.
Replace roof	105	Present roof leaks and can damage equipment. Use of wooden trusses requires liquid fire extinguishing system which must be replaced; metal truss roof required.
Replace floor to meet security requirements	30	New "Q cell" or equivalent floor must be laid over present floor to meet minimum RED/BLACK separation concepts.
Refit interior	60	Rearrange partitioning to provide adequate offices and equipment rooms to allow adequate sound and environmental control.
Revise air-conditioning	4	To meet minimum standards of environmental control for computing equipment.
Provide adequate fire protection	20	Should a serious fire occur, the present liquid system could essentially destroy up to $5,000,000 worth of equipment.
Provide adequate parking	5	Includes building demolition needed to clear space. Provision of adequate parking will save time of users.
Prepare 2 additional bays for occupancy	4	Two additional bays in Building 57.
Loss of efficiency during alterations	100	Even with the most careful planning, disruption due to alterations will cause a significant drop in operation efficiency.
TOTAL	$928	

dollars in costs avoided in this area. A more realistic estimate of costs would include this figure in the items in Table 4-8, bringing the total to $6,178,000.

TABLE 4-8

SUMMARY OF SAVINGS - BUILDING COSTS AVOIDED APPROACH

Conferencing Facilities	$ 200,000
Computing Facilities Construction	928,000
Common Building Approach	50,000
Total Savings	$1,178,000

4.4 JUSTIFICATION BASED ON IMPACT ON FUTURE PROGRAM

The total Air Force budget for fiscal year 1965 is approximately 20 billion dollars. Of this sum, a total of about 6 billion is directly influenced by the activities within Area "B". Aeronautical Systems Division alone is responsible for about 3.6 billions of dollars of which about one billion represents work for other services.

The savings realized through the R&T Center and its impact upon this very substantial flow of funds derive from the increased coordination between laboratories and other users all working on the same large programs. Improvements in flight control systems, for example, involve closely coordinated work involving the Aero Propulsion Laboratory, Avionics, Flight Dynamics, Aerospace Medical Research Laboratory, the Systems Engineering Group, and such ASD units as the Deputy for Advanced Systems Planning, the Deputy for Flight Test, and possibly one or more program offices.

The savings are realized in a number of ways. The carefully coordinated planning and simulation of new weapons helps to minimize the costly construction and test. The optimization studies of Air Force weapons effectiveness help to avoid the commencement of programs for which no real need will develop. The PERT analysis of existing programs helps to illuminate areas of unnecessary or wasteful expenditures.

It must, however, be noted that these highly technical activities requiring coordinate work between a number of diverse operating groups cannot simply be credited to the R&T Center. Quite evidently, such coordinated activities take place now, although at times under somewhat awkward working conditions. Some activities for which a need is seen to be developing (the simulation of complex surveillance missions, for example) simply cannot be accomplished with the present facilities and it would

be wasteful to concentrate in any one laboratory the extensive facilities needed for such a simulation. Nevertheless, the comparison is not that between total and zero coordination, but rather between a partially and a more effectively coordinated activity. Thus, it is difficult to establish a meaningful basis for a quantitative measure.

If, taking one approach, the existence of the R&T Center is assumed to be capable of effecting a 0.1% cost savings in the defense funds that are influenced by Area "B" activities, then this reasoning alone leads to savings on the order of 61 million dollars per year. Alternately, the same modest efficiency factor applied only to major programs such as future versions of the F-111, the RF4C, or the B-70 leads to savings in the millions of dollars. These extremely large figures are, however, difficult if not impossible to isolate clearly and justify completely.

All that can really be said is that weaponry development is becoming increasingly complex. More and more, the advances depend not upon clear-cut break-throughs in isolated technical areas but upon the interaction of advances in a number of scientific disciplines. In such an atmosphere of development, it is essential that the interdisciplinary efforts be closely coordinated. Thus, the reasoning leads inevitably to the conclusion that centers of coordination, such as the R&T Center described here, are required increasingly in technological complexes, such as Area "B".

It seems to be reasonable and, in fact, extremely conservative in view of the foregoing discussion, to assume a minimum savings impact of the R&T Center upon the Air Force program to be between $1,000,000 and $5,000,000 over a 5- to 10-year period.


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